Improving Energy Performance in Canada

Report to Parliament Under the *Energy Efficiency Act* For the Fiscal Year 2003–2004

CANADA'S **NATURAL RESOURCES**
NOW AND FOR THE **FUTURE**
nrcan.gc.ca

Natural Resources Canada | Ressources naturelles Canada

Canada

This digital mosaic of Canada, produced by Natural Resources Canada (Canada Centre for Remote Sensing), is a composite of individual satellite images. The differences in the density of vegetation are illustrated through shading.

Published by the authority of the Minister of Natural Resources Canada
Government of Canada

Aussi disponible en français sous le titre :
Améliorer le rendement énergétique au Canada –
Rapport au Parlement en vertu de la *Loi sur l'efficacité énergétique*, Pour l'année financière 2003-2004

Cat. No. M141-10/2004E
ISBN 0-662-39608-1

© Her Majesty the Queen in Right of Canada, 2005

To obtain additional copies of this or other free publications on energy efficiency, please contact

Energy Publications
Office of Energy Efficiency
Natural Resources Canada
c/o S.J.D.S.
1770 Pink Road
Gatineau Qc J9J 3N7
Tel.: 1 800 387-2000 (toll-free)
Fax: (819) 779-2833
TTY: (613) 996-4397 (teletype for the hearing-impaired)

You can also view or order most Office of Energy Efficiency publications on-line.
Visit our Virtual Library at oee.nrcan.gc.ca/publications.
The Office of Energy Efficiency's Web site is at oee.nrcan.gc.ca.

Recycled paper

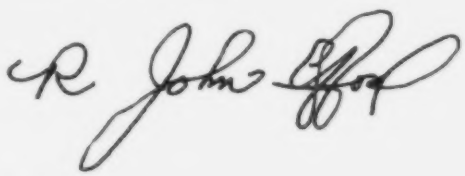
105-07421/

Her Excellency the Right Honourable Adrienne Clarkson,
C.C., C.M.M., C.D.
Governor General of Canada and Commander-in-Chief

Your Excellency,

I have the honour to present the *Report to Parliament Under the* Energy Efficiency Act for the fiscal year ending March 31, 2004, in accordance with Section 36 of the Act.

Respectfully submitted,



The Honourable R. John Efford, P.C., M.P.
Minister of Natural Resources Canada

Table of Contents

Minister's Foreword v

Executive Summary vii

Introduction 1

Greenhouse Gases and Climate Change 1

Natural Resources Canada's Efficiency and Alternative Energy Program 1

In This Report 2

Chapter 1: Policy Context and Legislation 3

Federal Policy and Measures on Energy Efficiency and Alternative Energy 3

Responsibility 4

Energy Efficiency Strategy 5

Alternative Energy Strategy 5

Policy Instruments 6

Leadership 6

Information 6

Voluntary Initiatives 6

Financial Incentives 6

Research and Development 6

Regulation 7

Compliance with Regulations, 2003–2004 7

Chapter 2: Trends in Energy Use 9

Introduction 9

Energy Use and Greenhouse Gas Emissions 9

Energy Intensity / Energy Efficiency 10

International Comparisons 10

Trends in Energy Efficiency 11

Trends in Renewable Energy 12

Chapter 3: Measuring Progress 13

Introduction 13

Focusing on Results 13

Data Collection and Analysis 13

Chapter 4: Housing 15

Energy Use and Greenhouse Gas Emissions 15

New Houses: R-2000 Standard and EnerGuide for (New) Houses 17

New Houses: Super E™ House Program 18

Existing Houses: EnerGuide for Houses and Retrofit Incentives 19

Residential Equipment: Energy Efficiency Standards and Regulations 20

Residential Equipment: Labelling and Promotion 21

Residential Equipment: Housing Energy Technology Program 23

Chapter 5: Buildings 25

Energy Use and Greenhouse Gas Emissions 25

New Buildings

Commercial Building Incentive Program 27

Industrial Building Incentive Program 27

Green Buildings Program 28

Existing Buildings

Energy Innovators Initiative 29

Equipment

Energy Efficiency Standards and Regulations 30

Labelling and Promotion 30

Buildings Program – Refrigeration Systems Equipment 31

Buildings Program – Intelligent Buildings 31

Building Energy – Simulation Program 32

Community Energy Systems

Community Energy Systems Program 33

Chapter 6: Industry 35

Energy Use and Greenhouse Gas Emissions 35

Industrial Processes and Technologies 37

Industrial Energy Efficiency 37

Cleaner Fossil Fuel Power Generation 39

Processing and Environmental Catalysis Program 40

Industrial System Optimization Program 41

Industry Energy Research and Development (IERD) Program 42

Emerging Technologies Program (ETP) 43

Industrial Energy Innovation 44

Minerals and Metals Program 45

Equipment

Energy Efficiency Standards and Regulations 46

Labelling and Promotion 46

Mine Ventilation 47

Chapter 7: Transportation 49

Energy Use and Greenhouse Gas Emissions 49

Vehicles

Vehicle Efficiency 51

Personal Vehicles 52

Fleet Vehicles 53

Transportation Research and Development

Canadian Lightweight Materials Research Initiative (CliMRI) 54

Fuel-Cell-Powered Mining Vehicles 55

Alternative Transportation Fuels

Future Fuels Initiative 56

Ethanol Expansion Program 56

Biodiesel Initiative 57

Canadian Transportation Fuel Cell Alliance 57

Hydrogen Economy and Transportation Energy Program 58

Chapter 8: Renewable Energy 59

Renewable Energy Use

Hydro-Electricity 59

Biomass 59

Earth Energy 60

Wind Energy 60

Solar Energy 61

Renewable Energy Programs

ENergy from the FORest (ENFOR) 62

Initiative to Purchase Electricity From Emerging Renewable Energy Sources 63

Photovoltaic and Hybrid Systems Program 64

RETScreen® International Clean Energy Decision Support Centre 64

Bioenergy Technology Program 65

Renewable Energy Deployment Initiative (REDI) 66

Renewable Energy Technologies (RET) Program 67

Wind Power Production Incentive (WPPI) 68

Market Incentive Program (MIP) 68

Chapter 9: Federal House in Order 69

Introduction 69

Federal Buildings Initiative (FBI) 70

Federal Industrial Boiler Program (FIBP) 71

Federal Vehicles Initiative 72

Chapter 10: General Programs 73

Outreach 73

Program of Energy Research and Development (PERD) 74

Climate Change Technology Development and Innovation Program (of the *Government of Canada Action Plan 2000 on Climate Change*) 74

International Initiative for Technology Development Program 74

Climate Change Technology and Innovation Research and Development and Innovation Program 75

Chapter 11: Intergovernmental Cooperation 77
Introduction 77
Green Municipal Funds 77
Federal-Provincial and Federal-Territorial Cooperation 77
General Cooperation 77
Cooperation Agreements 77
National Advisory Council on Energy Efficiency (NACEE) 78
Examples of Cooperation at the Program Level 78
R-2000 Standard and EnerGuide for Houses 78
Federal Buildings Initiative (FBI) 78
Commercial Building Incentive Program (CBIP) 78
Canadian Industry Program for Energy Conservation (CIPEC) 79
Energy Innovators Initiative (EII) 79
Equipment Energy Efficiency Regulations and Labelling 79
Initiative to Purchase Electricity From Emerging Renewable Energy Sources 79
Market Incentive Program for Distributors of Electricity from Emerging Renewable Energy Sources 79
Residential Wood Combustion 79
Personal Vehicles and Vehicle Fuels 80
Program of Energy Research and Development (PERD) 80
Technology and Innovation Research and Development (T&I R&D) 80
International Cooperation 80
International Energy Agency (IEA) 80
United Nations 81
China 81
Mexico 81
United States 81
United States and Mexico 82

Appendix 1: NRCan's Efficiency and Alternative Energy Initiatives and Expenditures, 2003–2004 83

Appendix 2: Data Presented in Report 85

List of Figures and Tables

Figures

FIGURE 1-1 Moving the Market 7
FIGURE 2-1 Canada: Changes in Energy Intensity and the Energy Efficiency Effect, 1990–2002 10
FIGURE 2-2 Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002 11
FIGURE 2-3 Electricity Production From Renewable Sources (GWh) 12
FIGURE 4-1 Canadian Households by Type of Dwelling, 2002 15
FIGURE 4-2 Residential Energy Use by Purpose, 2002 15
FIGURE 4-3 Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002 16
FIGURE 4-4 EnerGuide Rating for Houses Annual Heating Consumption for Houses Constructed to Different Standards 16
FIGURE 4-5 Average Energy Consumption per Household, Pre-1946 to 2000–2004 16
FIGURE 4-6 Number of Eligible R-2000 Housing Starts, 1990 to 2003 17
FIGURE 4-7 National Trends in Air Leakage (R-2000 and EnerGuide for Houses), Pre-1945 to 2000–2004 17
FIGURE 4-8 Evaluations Under EnerGuide for Houses, 1998–1999 to 2003–2004 19
FIGURE 4-9 Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2004 19
FIGURE 4-10 Eighth Amendment: Estimated Reductions in CO_2 Emissions, 2005 to 2020 20
FIGURE 4-11 ENERGY STAR® Label 21
FIGURE 4-12 Average Energy Consumption of New Appliances, 1990 and 2002 Models 22
FIGURE 4-13 Unit Energy Consumption for Top-Mounted Auto-Defrost Refrigerators Marketed in Canada, 1991 and 2004 Models 22
FIGURE 4-14 Impact of EnerGuide Labelling: Total Energy Savings and GHG Emissions Reductions Attributable to the EnerGuide for Equipment Program, 1990 to 2000 22

FIGURE 5-1 Commercial/Institutional Energy Use by Building Type, 2002 25
FIGURE 5-2 Commercial/Institutional Energy Use by Purpose, 2002 25
FIGURE 5-3 Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002 26
FIGURE 5-4 Energy Use in Commercial Buildings, 2000 26
FIGURE 5-5 Estimated Average GHG Reductions by Institution Under CBIP, 2003 to 2004 27
FIGURE 5-6 Energy Innovators Initiative – Incentive Projects, 1998 to 2004 29
FIGURE 5-7 Eighth Amendment: Estimated Reduction in CO_2 Emissions, 2005 to 2020 30
FIGURE 6-1 Industrial Energy Use by Sub-sector, 2002 35
FIGURE 6-2 Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2002 35
FIGURE 6-3 Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002 36
FIGURE 6-4 CIPEC Energy Intensity Index, 1990–2002 37
FIGURE 6-5 Industrial Energy Innovators, 1995–1996 to 2003–2004 37
FIGURE 7-1 Transportation Energy Use by Mode, 2002 49
FIGURE 7-2 Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002 49
FIGURE 7-3 Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2002 50
FIGURE 7-4 New Car Fuel Efficiency, Normalized for Weight and Power, 1990 to 2001 50
FIGURE 7-5 Changes in Trucking Energy Intensity and Average Activity per Truck, 1990–2002 50
FIGURE 7-6 Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2003 51
FIGURE 7-7 Vehicle Fuel Efficiency Awareness – EnerGuide Labels 52
FIGURE 7-8 Vehicle Fuel Efficiency Awareness – Auto$mart 52
FIGURE 7-9 Number of New Drivers Educated Using the Auto$mart Student Driving Kit, 1997–1998 to 2003–2004 52
FIGURE 7-10 EnerGuide Label for New Vehicles . . . 52
FIGURE 7-11 Drivers Trained and Participation in the Fleet Vehicle Program, 1997 to 2004 53
FIGURE 8-1 Canadian Wind Power Capacity, 1990 to 2003 60
FIGURE 9-1 GHG Emissions Reductions From Federal Operations, 1990–1991 to 2010–2011 69
FIGURE 9-2 Annual Energy Savings From the FIBP, 1992–1993 to 2002–2003 71
FIGURE 9-3 Federal Fleet Size and Fuel Consumption, 1995–1996 to 2002–2003 72
FIGURE 9-4 Purchases of Alternative Fuel Vehicles for the Federal Fleet, 1997–1998 to 2003–2004 72

Tables

TABLE 2-1 Energy Intensities for Selected IEA Countries 10
TABLE 2-2 Explanation of Changes in Secondary Energy Use, 1990 to 2002 12
TABLE 8-1 Renewable Energy Markets and Technologies Used in Canada 59
TABLE 8-2 Electricity Generation Capacity From Renewable Sources (Includes Hydro) 59
TABLE 8-3 REDI for Business Projects Completed, 1998 to 2004 66

Minister's Foreword

I am pleased to present the eleventh report to Parliament under the *Energy Efficiency Act*. It outlines the accomplishments in energy efficiency and the use of renewable energy that the Government of Canada has achieved through Natural Resources Canada (NRCan) in 2003–2004.

Working to improve energy efficiency remains a priority for the Government of Canada. Through its various programs, initiatives and regulations, NRCan has been helping governments, industry and individuals across Canada to increase energy efficiency and reduce consumption. Among our initiatives are a number of innovative research and development programs that have helped Canada become a world leader in clean and renewable energy technology.

Curbing the effects of climate change requires all of us to take action. That is why we have asked Canadians to take the One-Tonne Challenge and reduce their individual greenhouse gas emissions by 20 percent. Using less energy and using it wisely is something we all can do to reduce the effects of climate change.

NRCan will continue to support the responsible use of our energy resources. The EnerGuide for Houses Retrofit Incentive program is an example of this commitment. By encouraging Canadians to make efficiency improvements, decrease their own energy bills and reduce environmental impacts, this program is raising the level of energy efficiency in the housing sector.

The Government of Canada's approach to climate change is focused on making the right choices for Canada. By promoting energy efficiency and the use of renewable energy, NRCan is ensuring that the actions taken contribute to the long-term goals of building a sustainable economy for the 21st century, a healthier environment and strong communities, while affirming Canada's place in the world.

The Honourable R. John Efford, P.C., M.P.
Minister of Natural Resources Canada

Executive Summary

With the ratification of the Kyoto Protocol in 2002, Canada formally committed to a specific target for reducing its greenhouse gas (GHG) emissions to address the global issue of climate change. Canada's industrialized economy makes decreasing GHG emissions a particular challenge.

Canadians spend almost $114 billion per year on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. Several factors contribute to Canadian energy demand: a vast geography, a northern climate with extreme seasonal variations in temperature and an economy founded on an abundance of natural resources.

Types of Energy Use

There are two general types of energy use: primary and secondary. Primary use comprises Canada's total consumption, including energy required to transform one form to another – such as coal to electricity – and to deliver energy to consumers. Secondary use comprises energy consumed for residential, agricultural, commercial/institutional, industrial and transportation purposes.

Key highlights in energy use include the following:

- Between 1990 and 2002, the latest year for which figures are available, primary energy use increased by 21.5 percent.
- In 2002, secondary use accounted for 69.1 percent of primary energy use and produced 66.2 percent (482 megatonnes) of Canada's total GHG emissions. This last figure includes emissions produced by utilities in meeting the demand for electricity.
- Without improvements in energy efficiency made to buildings and equipment and the changes in the behaviour of energy users during the past several decades, the increases in energy use would have been much higher.

The industrial sector consumes the most energy, accounting for 38.7 percent of total secondary energy use in 2002. Transportation is second (28.1 percent), followed by residential (17.0 percent), commercial/institutional (13.8 percent) and agriculture (2.5 percent).

Five key factors contribute to changes in energy use:

- Activity – variations in levels of activity within sectors
- Weather – annual fluctuations
- Structure – shifts toward more or less energy-intensive activities
- Service level – increased penetration of auxiliary equipment and space cooling in commercial/institutional buildings
- Energy efficiency – how effectively energy is being used

Promoting Energy Efficiency

For the past decade, Natural Resources Canada (NRCan) has promoted energy efficiency and the use of alternative energy as a means to reduce GHG emissions and save money. NRCan exercises a broad range of policy instruments, including leadership, information, voluntary actions, financial incentives, research and development (R&D) and regulation. Regulation allows for the enforcement of compliance.

The *Energy Efficiency Act*, which came into force in 1992, provides for the making and enforcement of regulations concerning minimum energy performance levels for energy-using products, as well as the labelling of energy-using products and the collection of data on energy use. The *Energy Efficiency Regulations* are described in Chapters 4, 5 and 6, with an emphasis on their contribution to energy efficiency in the housing, building and industrial sectors, respectively.

Energy Intensity / Energy Efficiency

As explained in Chapter 2, although aggregate energy intensity is sometimes used as a proxy for energy efficiency, there is a difference between the two terms. Understanding this difference is important when comparing Canada with other countries. Energy intensity is a broader measure, capturing not only energy efficiency, but also the impacts of weather variations and changes in the structure of the economy (among other things). While Canada has a higher aggregated intensity than most International Energy Agency (IEA) countries, it has made significant overall improvements in energy efficiency. According to a recent IEA report[1] that examined 13 countries, Canada has the fourth fastest rate of energy efficiency improvement.

Evidence of Change

As explained in this report, recent growth in energy use is primarily due to increased activity in various sectors; however, this growth would have been far greater without improvements in energy efficiency. As reported in Chapter 2, energy efficiency improvements made between 1990 and 2002 are estimated to have reduced GHG emissions by almost 50 megatonnes and decreased energy expenditures by $11.6 billion in 2002.

Over this period, the residential sector recorded a 19.8 percent increase in energy efficiency. The figures for industry (14.2 percent), transportation (9.9 percent) and the commercial/institutional (7.3 percent) sectors demonstrate that improvements in energy efficiency are being made throughout the economy.

Through improvements in energy efficiency, Canadians can reduce the size of their energy bills and achieve important environmental goals. In the short term, changes to less GHG-intensive fuels (e.g. from coal to natural gas) can help reduce GHG emissions. However, over the long term, reducing GHG emissions to 1990 levels will require more widespread use of alternative energy.

In recent years, the production of energy derived from alternative sources has increased significantly. Between 1990 and 2001, the last year for which data are available, the amount of electricity generated from the sun, wind and biomass increased by 204 percent.

Measuring Progress

The goal of NRCan's efficiency and alternative energy (EAE) initiatives is to improve energy use by altering energy-consumption practices and patterns in Canada. Measuring the effectiveness of the initiatives is of paramount importance to the success and viability of EAE.

NRCan regularly measures three aspects of EAE programs. **Program outputs** are items produced on a regular basis, such as marketing and informational materials, demonstration projects, financial incentives and regulations. These items are designed to deliver **program outcomes**, such as changes in behaviour. These alterations lead to **market outcomes**, such as observable differences in the amount and type of energy consumed.

Engaging Canadians

To maximize the effectiveness of its initiatives, NRCan engages a growing number of partners from the private and public sectors. Dozens of cooperative agreements are in place with a broad range of businesses, community groups and other levels of government.

These initiatives engage Canadian society, along with every sector of the economy, in new and more efficient approaches to secondary energy use and in the development and deployment of renewable energy sources.

This report provides an overview of the work being done in each sector, highlights NRCan's EAE programs and lists their key achievements for 2003–2004. All programs are described in the corresponding sector chapter. Program entries for market transformation programs also include quantitative performance indicators in graph or table format. A list of NRCan's EAE initiatives and expenditures appears in Appendix 1.

[1] *Oil Crises and Climate Challenges – 30 Years of Energy Use in IEA Countries*, Paris, IEA, 2004.

Housing

The residential sector accounts for 17 percent of total secondary energy use and 15.6 percent of Canada's annual GHG emissions. Between 1990 and 2002, residential energy use increased by 8.6 percent, while GHG emissions increased by 8.4 percent. The growth in energy use was largely due to increased activity.

Improvements in energy efficiency, through superior construction of new homes and reduced energy use by occupants, moderated that increase. Without these improvements, which were supported by NRCan programs, total residential energy consumption would have been 19.8 percent higher.

NRCan programs in the housing sector focus on three areas: new houses, existing houses and residential equipment. The majority of dwellings in Canada are detached and semi-detached houses, so most NRCan programs in this sector focus on these types of homes.

New Houses

Houses built in Canada today are more energy efficient than ever. For example, air-leakage rates have improved dramatically. Data recorded during audits performed under EnerGuide for Houses demonstrate that, prior to retrofits, the average number of air changes per hour for homes built before 1945 was 12; the number for homes built between 2000 and 2004 is 8.

NRCan's R-2000[1] Standard encourages Canadian builders to build, and Canadian consumers to purchase, houses that are more energy efficient and environmentally responsible than is required by current Canadian building codes. A house built to the R-2000 Standard undergoes only 1.1 air changes per hour and consumes 64 percent less energy than the average house constructed in 1970. EnerGuide for (New) Houses is an energy-performance rating and labelling scheme based on the R-2000 Standard, but targets large-volume, mass-market builders.

NRCan's Super E™ House Program[2] supports the export of energy-efficient and environmentally friendly housing technology to foreign builders. Thanks to this program, the R-2000 concept has been adapted to several international markets. Since the program began in 1998, 91 units have been built in Japan and 92 units in the United Kingdom. In both Japan and the U.K., Super E™ is now established as high quality housing uniquely available from Canada and its exporters.

Existing Houses

NRCan programs for existing houses encourage Canadians to improve the energy efficiency of their homes, particularly when undertaking renovation and maintenance projects. In October 2003, a retrofit incentive was launched whereby homeowners can qualify for a non-taxable grant when retrofitting their homes. Homeowners who completed retrofit activities experienced an average annual energy savings of 19 percent.

In 2003–2004, more than 48 000 houses underwent energy evaluations. Retrofitted homes saw a reduction in energy consumption of between 20 and 38 percent; grant recipients reduced their carbon dioxide emissions by an average of 4 tonnes per year, per house.

Residential Equipment

NRCan develops regulations and sets standards for the energy performance of residential equipment, such as appliances and furnaces. Through labelling and promotional activities, NRCan also encourages the manufacture and purchase of more energy-efficient equipment. Residential equipment programs consist of EnerGuide for Equipment and the international ENERGY STAR® label.

From 1990 to 2000, the EnerGuide labelling program is estimated to have resulted in a total energy savings of 531 gigawatt hours and a reduction of 287 kilotonnes of GHG emissions. From 2003–2004, over 140 organizations have been recruited to participate in and promote ENERGY STAR® in Canada.

[1] R-2000 is an official mark of Natural Resources Canada.
[2] Super E is an official mark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

Buildings

Retail and office space account for more than half of the commercial/institutional sector's energy demands. Between 1990 and 2002, commercial/institutional energy use (excluding street lighting) increased by 30.8 percent. In 2000, the commercial/institutional sector accounted for 13.8 percent of total secondary energy use and 13.4 percent of GHG emissions. However, improvements in energy efficiency worked to decrease total energy use by 7.3 percent.

NRCan programs address all building types with measures that target new buildings, existing buildings and equipment.

New Buildings

NRCan provides financial incentives to builders and developers who incorporate energy-efficient features into new construction projects. Since its inception, the Commercial Building Incentive Program has issued incentives to 372 projects, thereby avoiding 78 kilotonnes of GHG emissions.

NRCan also provides assistance to builders and developers of industrial structures. In 2003–2004, six contribution agreements were signed; moreover, 17 architects and engineers received training on energy-efficient industrial building design.

Existing Buildings

NRCan provides commercial organizations and public institutions with access to tools and financial assistance to improve the energy efficiency of their existing buildings. Between 1998 and 2004, federal contributions to renovation and retrofitting projects totalled $30.5 million, and client investment equalled $571.4 million. Energy savings achieved through these projects was worth $80 million.

Equipment

Through a range of equipment programs, NRCan establishes standards and regulations for energy efficiency and supports the development, testing, deployment and promotion of new technologies.

In 2003–2004, NRCan established minimum performance standards for water chillers and exit signs; the cumulative annual reductions attributable to these standards are estimated to be approximately 0.02 megatonnes in the year 2005 and 0.17 megatonnes in the year 2020. NRCan also provides comparative information on the energy performance of equipment and uses the international ENERGY STAR® label to identify the most energy-efficient products available.

Through its Refrigeration Action Program for Buildings, NRCan supports the development and adoption of refrigeration technologies that reduce energy consumption, synthetic refrigerant use and GHG emissions. In 2003–2004, the program launched a demonstration project of integrated heating, ventilation and air conditioning (HVAC) and refrigeration technologies in a Quebec supermarket, as well as in three ice rinks.

NRCan also helps to develop and promote the adoption of intelligent building technologies and practices that reduce energy consumption and GHG emissions. Furthermore, NRCan distributes and supports building simulation software for the Canadian housing and building industry. To date, the software has simulated improved energy efficiency for over 128 000 houses and 380 commercial buildings.

Community Energy Systems

NRCan works in partnership with Canadian communities and businesses to develop Sustainable Community Energy Plans, using tools that will help reduce energy demand, emphasize conservation and promote reliance on local renewable energy sources. In 2003–2004, NRCan developed a planning methodology that enables municipalities to develop a long-term growth strategy while minimizing energy consumption and maximizing renewable energy use.

Industry

The industrial sector includes all manufacturing industries, all mining activities, forestry and construction, but excludes electricity generation. Overall, industrial energy demand accounts for 38.7 percent of secondary energy use and 33.8 percent of GHG emissions.

Between 1990 and 2002, industrial energy use increased by 16.9 percent, while industrial GHG emissions grew by 15.2 percent.

Improvements in energy efficiency helped reduce total energy use by 14.2 percent. Within this sector, NRCan's energy efficiency initiatives focus on industrial processes and technologies, equipment and buildings.

Industrial Processes and Technologies

NRCan works with companies and associations to address barriers to planning, implementing, tracking and reporting energy efficiency improvement targets in industry. Between 1990 and 2002, the Canadian Industry Program for Energy Conservation achieved an average energy intensity improvement of 1.9 percent per year, thereby avoiding 23.8 megatonnes of GHG emissions.

NRCan also designs, develops and deploys technologies for cleaner fossil fuel power generation. In 2003–2004, NRCan devised a new combustion protocol for assessing energy and emission performance of bitumen/water emulsions for industrial applications.

NRCan supports Canadian industry in the development and adoption of innovative energy-efficient practices, such as Process Integration (PI) and advanced process control systems. In 2003–2004, NRCan completed a successful PI collaboration that identified energy savings of $4.5 million per year and GHG reductions of 34 kilotonnes per year.

In 2003–2004, NRCan helped finance a company that is developing a new mechanical transmission for diesel generator sets. NRCan also is supporting the development of a production-scale process that recycles post-industrial polyethylene cross-linked foam waste material into foam sheet products.

The *Government of Canada Action Plan 2000 on Climate Change* has allocated $10 million to the Minerals and Metals Program, which has its home in the Minerals and Metals Sector of NRCan.

Equipment

Through regulation, standards setting, labelling and research support, NRCan programs work to improve the energy efficiency of equipment used in industry.

Canada's *Energy Efficiency Regulations* set out minimum performance standards through the *Energy Efficiency Act* to eliminate the less energy-efficient models of energy-using equipment from the market. EnerGuide for Equipment promotes and encourages the manufacture, purchase and use of more energy-efficient industrial equipment. In 2003–2004, market studies were completed for compressors, uninterruptible power supplies, battery chargers, arc welders and pumps.

Transportation

The transportation sector accounts for 28.1 percent of secondary energy use and 34.2 percent of GHG emissions. This sector is divided into three sub-sectors: passenger, which comprised 56.7 percent of the sector's total energy use in 2002; freight, 39.3 percent; and off-road, 4.0 percent.

Between 1990 and 2002, transportation energy use grew by 22.8 percent. Two main factors were responsible for the rise: an increase in activity and shifts between modes of transport. In the light-duty vehicle mode, although the fuel efficiency of new vehicles has improved markedly, average fuel economy has not changed significantly, because new cars and trucks are increasingly heavier and feature more powerful engines.

Between 1990 and 2002, improvements in energy efficiency reduced energy use in this sector by 9.9 percent from what it would have been in the absence of such improvements.

In 2002, road transport, at 78.1 percent, was the largest user of energy in the sector. Passenger energy use accounted for 60.5 percent of that total, and freight, 39.5 percent. In this sector, NRCan focuses its energy-use programs on road transport, dividing them into four areas: vehicles, R&D, alternative transportation fuels and longer-term transportation technology.

Vehicles

NRCan intends to bring about a 25 percent improvement in the fuel efficiency of new light-duty vehicles sold in Canada by 2010. GHG reductions of 5.2 megatonnes by 2010 are being sought.

NRCan programs encourage manufacturers to meet targets for fuel consumption and to improve fuel efficiency by adopting advances in technology. Parallel programs encourage motorists to purchase energy-efficient vehicles. Under a voluntary agreement, manufacturers attach EnerGuide fuel-consumption labels to vehicles to help purchasers make informed buying decisions.

In 2003–2004, Idle-Free Awareness campaigns were completed in many cities across Canada and a Tire Inflation campaign was developed and launched.

In partnership with fleets, industry stakeholders and other levels of government, NRCan delivers information materials, workshops, demonstrations and training to fleet operators to help improve fuel efficiency and encourage the use of alternative fuels such as natural gas in commercial and municipal fleets.

During 2003–2004, the SmartDriver workshops trained more than 160 000 novice and experienced drivers in fuel-efficient driving techniques and introduced over 700 new instructors to the Fleet Vehicles Initiative.

Transportation Research and Development

NRCan supports research into transportation technologies that improve the energy efficiency of vehicles and reduce GHG emissions.

During 2003–2004, recent developments in hydroforming have enabled significant productivity gains and weight reductions for complex structural components in the automotive industry.

In the mining industry, NRCan plays a lead role in a consortium that is developing a mining vehicle powered by fuel cells. The fuel cell locomotive is now undergoing long-term reliability testing of the fuel cell power plant.

Alternative Transportation Fuels

NRCan promotes the use and development of alternative fuels, such as ethanol and biodiesel, to minimize environmental impacts.

NRCan's Future Fuels Initiative, co-managed with Agriculture and Agri-Food Canada, aims to increase the supply and use of fuel ethanol produced from biomass. In 2003–2004, the initiative completed an ethanol-blended gasoline awareness campaign in partnership with Ontario and Quebec fuel retailers.

During 2003–2004, as part of its Ethanol Expansion Program, NRCan allocated contributions to seven projects from across Canada that plan to increase domestic ethanol production by a total of 750 million litres per year.

NRCan's Biodiesel Initiative supports the Government of Canada's proposed target of 500 million litres of biodiesel production per year by 2010.

Transportation Technologies

NRCan, in partnership with industry, develops and evaluates hydrogen and fuel cell technologies to reduce GHG emissions and minimize other environmental impacts.

In 2003–2004, the Canadian Transportation Fuel Cell Alliance, a public-private initiative, produced a draft hydrogen installation code for Canada and participated in ongoing codes and standards activities at a national and international level.

In partnership with industry, NRCan is working to develop and deploy leading-edge hydrogen and transportation technologies that will reduce GHG emissions.

Renewable Energy

Most of the renewable energy used in Canada comes from either hydro-electricity or thermal energy from biomass. In 2002, renewable energy generation capacity from renewable sources accounted for 61 percent of total Canadian electricity capacity.

In 2003, hydro power accounted for approximately 60 percent of total electricity generation; small-scale hydro-electric projects constitute about 4 percent of Canada's electricity-generating capacity and offer potential for increased production. Several other renewable energy sources and technologies exist in Canada: bioenergy, earth energy, wind energy and solar energy.

Bioenergy, a renewable source of energy derived from biomass, contributes about 6 percent of Canada's primary energy and represents Canada's second largest renewable energy source. Earth energy, produced by ground-source heat pumps, supplies less than 1 percent of the market for space and water heating and cooling in Canada.

In 2003, wind energy accounted for less than 1 percent of Canada's total electricity generation; however, the potential is much greater. An NRCan study estimated that wind energy potentially could supply 11 percent of total Canadian electricity consumption.

Three main technologies use solar energy: passive solar technologies, active solar thermal systems and solar electric (photovoltaic) systems. The Canadian Coast Guard is the largest individual user of photovoltaic

systems in Canada, with an estimated 7000 navigational buoys, beacons and lighthouses.

NRCan delivers several initiatives to increase the use of small-scale renewable energy in Canada. These initiatives support education and promotion programs, develop standards and research, and provide financial incentives for capacity building.

Renewable Energy Programs

Between 1998 and 2001, NRCan entered into pilot projects to purchase electricity from emerging renewable energy sources (ERES). NRCan has pledged to purchase 20 percent of its electricity from ERES by 2010.

Through the Photovoltaic and Hybrid Systems Program, NRCan initiated a partnership to develop and demonstrate a multi-energy (hybrid) technology that will combine and integrate several types of renewable energy into a single system with a generator.

More than $2.5 million in federal incentives was distributed to 89 projects under the Renewable Energy Deployment Initiative, valued at $22 million.

In 2003–2004, the Renewable Energy Technologies Program funded work toward the development of "new and improved engineering designs of equipment for small hydro power plants to increase efficiency and reduce costs.

NRCan's Wind Power Production Incentive (WPPI) aims to support the installation of 1000 megawatts of new wind energy capacity by 2007. By displacing other sources, wind power capacity installed under the WPPI is projected to reduce annual GHG emissions by 3 megatonnes by 2010. In 2003–2004, guidelines were developed to assist wind developers, utilities and businesses in preparing an Environmental Impact Statement under the *Canadian Environmental Assessment Act*.

The Market Incentive Program is a $25-million program to stimulate emerging markets for renewable electricity. The Government of Canada will provide a short-term financial incentive of up to 40 percent of the eligible costs of an approved project. In 2003–2004, three contribution agreements were signed with the provincial governments of New Brunswick, Ontario and Prince Edward Island.

Federal House in Order

As the country's largest single enterprise, the Government of Canada is getting its own energy-use house in order. The Government of Canada has established a target of a 31 percent reduction in its GHG emissions by 2010.

The Government of Canada has already achieved a 24 percent reduction since 1990 through a series of measures, including building retrofits, improvements in fleet management, downsizing of operations and purchases of "green" power. In 1990, emissions were 3925 kilotonnes; in 2002, emissions were down to 2971 kilotonnes; the 2010 target is 2724 kilotonnes.

The departments and agencies responsible for 95 percent of federal GHG emissions have been assigned specific targets under a three-year action plan and must report annually on their programs. NRCan provides services and support to federal departments and agencies to help them achieve their energy efficiency targets.

The Federal House in Order initiative includes such activities as GHG inventory and tracking, purchases of "green" power and efforts to reduce outside emissions.

Federal Initiatives

Under the Federal Buildings Initiative (FBI), NRCan, through public-private partnerships, helps federal government organizations implement energy efficiency improvements in order to reduce energy use, GHG emissions and operating costs.

During 2003–2004, $25.6 million was invested by the private sector in FBI projects. FBI projects had an average energy intensity improvement of 20 percent by project.

The Federal Industrial Boiler Program (FIBP) provides technical and project-management services to federal departments and agencies that are implementing energy efficiency projects. Since its inception in 1991, the FIBP has worked with many federal government departments to reduce energy costs. These partnerships have reduced GHG emissions by an average of 4.7 kilotonnes per year.

Through the Federal Vehicles Initiative, NRCan assists other federal departments and agencies in improving the efficiency of their fleets and switching to cleaner burning fuels. During 2003–2004, the Government of Canada acquired 293 alternative fuel vehicles. Additionally, three new alternative fuel sites were established and two additional sites are under construction.

General Programs

Outreach

The Office of Energy Efficiency's Outreach program provides information and activities to increase Canadians' awareness and understanding of climate change and the link to energy use, and to encourage Canadians to take action. The program also targets youth as future energy consumers.

In 2003–2004, there was a 30 percent increase in the volume of publications distributed and a 300 percent increase in Web site visits, indicative of increasing interest in energy efficiency.

The One-Tonne Challenge was launched in March 2004. The One-Tonne Challenge asks Canadians to reduce their personal annual GHG emissions by one tonne by using less energy, reducing waste and conserving water and other resources.

Program of Energy Research and Development

NRCan funds R&D designed to ensure a sustainable energy future for Canada in the best interests of our economy and our environment. In 2003–2004, NRCan allocated $41.5 million to energy R&D programs managed and performed in the department.

Climate Change Technology Development and Innovation Program

NRCan aims to accelerate the development of cost-effective R&D mitigation technologies in multiple sectors. In 2003–2004, 15 new R&D projects were near completion.

International Initiative for Technology Development

In 2003–2004, NRCan launched the Clean Energy Technology Portal and provided marketing support at five national and international conferences.

Climate Change Technology and Innovation Research and Development

In 2003–2004, NRCan allocated $5.1 million to energy R&D programs managed and performed in the department.

Introduction

Greenhouse Gases and Climate Change

Climate change is a global challenge arising from the continuing buildup in levels of anthropogenic (human-produced) greenhouse gases (GHGs) in the atmosphere, in addition to naturally occurring emissions. GHGs are composed of a number of gases, and the main source of anthropogenic emissions is the combustion of fossil fuels. In December 1997, Canada and more than 160 other countries met in Kyoto, Japan, and agreed to targets to reduce GHG emissions. Canada's target is to reduce its GHG emissions to 6 percent below 1990 levels by the first commitment period (2008 to 2012). The Government of Canada ratified the Kyoto Protocol and notified the United Nations of its decision on December 17, 2002.

Natural Resources Canada's Efficiency and Alternative Energy Program

Since the early 1990s, Natural Resources Canada (NRCan) has emphasized the promotion of energy efficiency and the use of alternative energy (i.e. alternative transportation fuels and renewable energy) as a means to reduce GHG emissions, particularly in relation to the Kyoto Protocol. A complete list of NRCan's efficiency and alternative energy (EAE) initiatives in 2003–2004 is provided in Appendix 1. These initiatives engage Canadian society and all major sectors of the economy in new and more advanced approaches to secondary energy use – i.e. to the consumption of energy in the residential, commercial/institutional, industrial and transportation sectors.

NRCan's EAE initiatives are managed by

- the Office of Energy Efficiency, which delivers market transformation initiatives to improve energy efficiency and the use of alternative transportation fuels
- the CANMET[1] Energy Technology Centre and the Mineral Technology Branch, which deliver EAE research and development (R&D) initiatives
- the Electricity Resources Branch, which delivers market transformation initiatives for renewable energy
- the Science Branch of the Canadian Forest Service, which undertakes R&D in the use of forest biomass for energy

In its efforts to reduce GHG emissions, NRCan emphasizes partnership and cooperation with stakeholders, such as other levels of government, the private sector and non-governmental organizations. Using this approach, the demand side of the energy market moves toward more energy-efficient capital stock, production processes and operating practices without reducing service or comfort levels. On the supply side, Canada participates in developing technology for tapping renewable energy resources and alternative transportation fuels as well as for increasing the energy efficiency of production.

[1] CANMET is the Canada Centre for Mineral and Energy Technology.

In This Report

This eleventh annual Report to Parliament focuses principally on EAE initiatives that address secondary energy use. Chapter 1 provides the policy context and strategic overview. Trends in energy use and GHG emissions in Canada are discussed in Chapter 2. Chapter 3 summarizes work undertaken during the reporting period to improve the quality and coverage of performance indicators for the initiatives described in Chapters 4 through 9. Chapters 4 to 7 review individual EAE initiatives to improve energy use in housing, buildings, industry and transportation, highlighting their achievements and progress indicators. Chapter 8 deals with renewable energy sources and use. Chapter 9 describes the Government of Canada's actions to improve its own use of energy. Chapter 10 describes general programs not specific to EAE initiatives discussed in Chapters 4 to 9. The final chapter describes intergovernmental cooperation in EAE. Appendix 1 contains information on NRCan's EAE expenditures. Appendix 2 contains detailed information on the data presented in this report.

Chapter 1: Policy Context and Legislation

Federal Policy and Measures on Energy Efficiency and Alternative Energy

Energy use has been a policy concern since the 1970s when governments responded to the oil crises of 1973 and 1979 by promoting energy conservation and renewable energy sources. Toward the end of the 1980s, individuals, organizations and governments around the world became concerned that greenhouse gas (GHG) emissions produced by burning fossil fuels – such as coal, oil and natural gas – could contribute to climate change. In 1990, Canada's concern about its GHG emissions (which result mostly from energy use) created a new objective for a revitalized set of federal measures to encourage investment in corporate and consumer efficiency and alternative energy (EAE) opportunities.

The federal budget of February 1997 provided $60 million over three years for new initiatives to improve energy efficiency in new commercial buildings; encourage commercial building retrofits; provide for energy performance assessments of houses; and stimulate demand for cost-effective, commercially available renewable energy systems for space and water heating and cooling. This funding was renewed in the February 2000 federal budget and further extended to March 2006 in the budget of February 2003.

In 1992, Canada signed and ratified the *United Nations Framework Convention on Climate Change* (UNFCCC). In December 1997, at the third Conference of the Parties to the UNFCCC in Kyoto, Japan, the participating countries agreed to reduce GHG emissions from 1990 levels within 2008 to 2012. Canada pledged to reduce its emissions by 6 percent. The Government of Canada ratified the Kyoto Protocol and notified the United Nations of its decision on December 17, 2002. With Russia's ratification on October 25, 2004, the Protocol entered into force on February 16, 2005.

In February 1998, the federal budget provided $150 million over three years for a Climate Change Action Fund to help Canada develop its response to the Kyoto Protocol. This funding was renewed for another three years in the February 2000 federal budget. The fund has five components:

- **Building for the Future** – to sustain domestic efforts to address climate change and to enable Canada to meet GHG-reporting obligations
- **International Policy and Related Activities** – to enable Canada to enhance its international analysis and negotiating capacity
- **Public Education and Outreach** – to build public awareness and understanding
- **Technology Early Action Measures (TEAM)** – to demonstrate cost-effective technologies
- **Science, Impacts and Adaptation** – to advance the knowledge of the magnitude, rate and regional distribution of the impacts of climate change on Canada and to support the development of adaptation strategies

The federal, provincial and territorial governments established the National Climate Change Process in 1998 to examine the impact, costs and benefits of the Kyoto Protocol and the implementation options open to Canada. From spring 1998 to winter 1999–2000, the process engaged more than 450 experts from across Canada, and their recommendations were provided to governments in fall 2000. In October 2000, the Government of Canada announced its *Action Plan 2000 on Climate Change*, representing its contribution to *Canada's First National Climate Change Business Plan* developed with the provinces and territories. Funding of $500 million over five years was provided in the budget update of October 2000 for a broad range of measures that commenced operation in 2001–2002.

In November 2002, the Government of Canada released the *Climate Change Plan for Canada*, outlining a three-step approach: the first being the measures implemented under *Action Plan 2000 on Climate Change*; the second, a set of new initiatives; and the third, options for attaining the target by the end of the first commitment period in 2012. The federal budget of February 2003 provided new funding of $2 billion over five years commencing with fiscal year 2003–2004 for a wide range of climate change initiatives identified in the Plan. On August 12, 2003, the details of the investment of $1 billion of this amount were announced. Many of these measures were implemented under the authority of the *Energy Efficiency Act* and are included in this report.

Responsibility

The following organizations within Natural Resources Canada (NRCan) are responsible for the initiatives described in this report.

The Office of Energy Efficiency (OEE) was established in April 1998 with a mandate to strengthen and expand Canada's commitment to energy efficiency, in particular to help address the challenges of climate change. The OEE's initiatives target all final energy consumers and emphasize partnerships and economic investment. Its program objectives are to overcome the market barriers posed by inadequate information and knowledge about energy efficiency and alternative transportation fuels, and to address institutional deterrents in energy-use markets and economic constraints that energy users face. The OEE is also responsible for identifying opportunities for new and heightened energy efficiency measures. The National Advisory Council on Energy Efficiency assists the OEE by providing advice and guidance. The council comprises energy efficiency experts and leaders from all sectors of the economy.

NRCan's Office of Energy Research and Development (OERD) strategically plans, manages and funds non-nuclear energy R&D for the Government of Canada that supports Canada's energy priorities. Through the interdepartmental Program of Energy Research and Development (PERD), the OERD provides more than 50 percent of its annual $57-million budget to study options related to energy efficiency and alternative energy. PERD also focuses on finding technology solutions to help Canada address its climate change challenges.

OERD also manages the Technology and Innovation Research and Development (T&I R&D) initiative, part of the *Climate Change Plan for Canada* announced in 2003. T&I R&D programs will play an important role over the next five years in accelerating the expansion of knowledge and the development of technologies to help achieve GHG greenhouse gas reductions in the longer term. Energy efficiency will be a key element. As well, the OERD coordinates the Government of Canada's participation in international energy R&D. Canada's objectives are mainly advanced through the International Energy Agency working parties, implementing agreements and the Committee for Energy Research and Technology, chaired by NRCan. NRCan also fosters collaborative energy R&D with the United States and Mexico.

The CANMET Energy Technology Centre (CETC) focuses on technology development and deployment. Technology development activities are performed on a cost-shared basis either through in-house R&D work at its laboratories or by providing funding support to its technology partners. CETC–Ottawa, in Ontario, works in partnership with a range of stakeholders to develop and disseminate innovative, cleaner energy technologies. These include energy-efficient technologies for homes, businesses and industry; renewable energy; alternative transportation fuels; district heating and cooling systems; advanced low-emissions combustion technologies; and energy-efficient metallurgical fuel products and technologies. CETC–Varennes, in Quebec, develops technologies that use energy wisely and help Canadians stay competitive in the marketplace. These include advanced drying technologies, heat transfer and storage systems, photovoltaics, renewable energy for remote communities and related software tools, such as RETScreen® International.

The Electricity Resources Branch's Renewable and Electrical Energy Division promotes the development of a sustainable renewable energy industry in Canada. It promotes investments in renewable energy systems for heating and cooling and provides information on renewable energy technologies. By strengthening markets for the renewable energy industry, its programs contribute to GHG reductions, job creation and export sales.

Outside of the Energy Technology and Programs Sector and the Energy Policy Sector, two other sectors within NRCan report on programs related to energy efficiency and alternative energy in this document. They are the Canadian Forest Service and the Minerals and Metals Sector.

The Canadian Forest Service of NRCan, in collaboration with partners from other governments, industry and universities, undertakes research in the areas of forest and biomass inventory and in the selection and testing of fast-growing forest crops. These activities address sustainability issues of R&D in the forest sector, rural and aboriginal forestry, and the protection of Canadian markets for forest products.

The Minerals and Metals Sector (MMS) of NRCan advances policies, science, regulations and knowledge that increase the contribution of the minerals and metals industries to Canada. MMS is committed to assisting Canada in reducing GHG emissions under the Kyoto Protocol. Initiatives now in place working towards that end are

- the *Government of Canada Action Plan 2000 on Climate Change* Minerals and Metals Program is working to reduce Canada's GHG emissions by enhancing mineral and metal recycling practices and assessing alternate production processes in industrial areas with high GHG-emitting activities
- ventilation on demand for underground mines that matches ventilation flow with production needs
- hydrogen-fuel-cell-powered vehicles for the underground mine environment
- the Canadian Lightweight Materials Research Initiative that develops low-density, high-strength, lightweight materials for more fuel-efficient ground transportation vehicles

Energy Efficiency Strategy

Most of NRCan's EAE initiatives deal solely with energy efficiency. Their goal is to improve energy efficiency by

- increasing the energy efficiency of new and existing buildings, equipment, systems and vehicles
- persuading individuals and organizations to purchase buildings, equipment, systems and vehicles that are more energy efficient
- influencing the energy-use practices of individuals and organizations
- developing technologies to give consumers, industry and communities new opportunities to improve energy efficiency

These measures help the demand side of the energy market move toward more energy-efficient capital stock, production processes and operating practices without reducing service or comfort levels.

Alternative Energy Strategy

Alternative energy includes renewable sources other than large hydro-electric facilities, new applications of conventional sources and new fuels, such as hydrogen for fuel cells. (Large hydro is not considered an alternative energy source because it is already a successful, well-established mode of energy production, supplying more than 60 percent of the electricity in Canada.) Some technologies, such as those related to the use of propane as a vehicle fuel and to forestry biomass, are already commercially available and accepted. Some have found applications in specialized markets, such as remote communities. Others are still in the early stages of development.

NRCan supports R&D to reduce costs, improve performance, develop safety and performance standards and increase the scope of renewable energy technologies. The department also provides incentives for investments in renewable energy systems and purchases of electricity generated from renewable sources, disseminates information to consumers, and assesses economic and environmental aspects of renewable sources of energy.

Federal initiatives are helping to expand the infrastructure (e.g. fuelling stations) for the sale of alternative transportation fuels, especially in urban areas where the provision of infrastructure is more economic. R&D focuses on ways to improve options in the use of these fuels.

Policy Instruments

NRCan's key policy instruments are as follows:

- leadership
- information
- voluntary initiatives
- financial incentives
- research and development
- regulation

Leadership

Leadership means setting an example for other levels of government and for the private sector by increasing energy efficiency and the use of alternative energy in the Government of Canada's operations.

Information

NRCan disseminates information to consumers, using methods that range from broad distribution to individual consultations with clients, to increase awareness of the environmental impact of energy use and to encourage consumers to become more energy efficient and to make greater use of alternative energy sources. Activities include publications, exhibits, advertising, toll-free lines, conferences, Web sites, workshops, training, building-design software and promotional products.

Voluntary Initiatives

Companies and institutions work with NRCan on a voluntary basis to establish and achieve energy efficiency objectives. NRCan's voluntary EAE initiatives target large consumers of energy in the commercial/institutional and industrial sectors and organizations whose products are important determinants of energy use. The initiatives involve industry-government agreements and, for groups of large industrial energy users, energy efficiency target setting. NRCan provides a variety of support services to assist and stimulate action by companies and institutions on energy efficiency, including developing standards and training.

Financial Incentives

NRCan uses financial incentives to encourage final users of energy to employ energy efficiency and renewable energy technologies and practices when they acquire, design or build new buildings or retrofit existing ones. NRCan also offers financial incentives for wind energy and for natural gas vehicles and refuelling infrastructure.

Research and Development

NRCan's EAE initiatives support the development and dissemination of more energy-efficient equipment, processes and technologies and alternative energy technologies. R&D also provides the scientific knowledge needed to develop the technologies, codes, standards and regulations required for the sustainable use of energy.

NRCan provides national leadership in energy science and technology (S&T) by undertaking in-house research in its own laboratories, by contracting out research activities to other organizations and through the federal PERD. PERD and TEAM are the only federal interdepartmental S&T investment funds that focus on the energy sector and its economic and environmental effects.

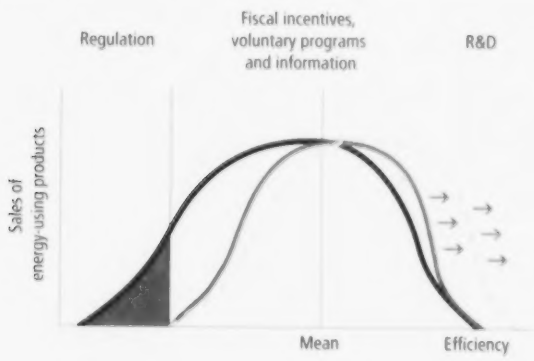
Regulation

The *Energy Efficiency Act* gives the Government of Canada the authority to make and enforce regulations concerning EAE, primarily performance and labelling requirements for energy-using products (as well as doors and windows) that are imported or shipped from province to province.

Figure 1-1 shows how these policy tools work together to increase energy efficiency, i.e. how they help to reduce the amount of energy needed to obtain a certain level of service. R&D increases the opportunities for achieving greater levels of efficiency in a particular type of energy use. Non-R&D measures increase the take-up of existing opportunities to use energy more efficiently. Energy performance regulations eliminate less-efficient products from the market.

FIGURE 1-1

Moving the Market



Compliance with Regulations, 2003–2004

The *Energy Efficiency Act*, passed in Parliament in 1992, provides for the making and enforcement of regulations concerning minimum energy performance levels for energy-using products, as well as the labelling of energy-using products and the collection of data on energy use. The first *Energy Efficiency Regulations* (the Regulations) came into force in 1995 and have established energy efficiency standards for a wide range of energy-using products. They apply to prescribed energy-using products imported into Canada or manufactured in Canada and shipped from one province to another for the purposes of lease or sale. Since 1995, there have been several amendments to the Regulations. NRCan is continually looking to improve the energy efficiency of energy-using equipment in Canada.

The Regulations are described further in Chapters 4, 5 and 6 of this report, with an emphasis on their contribution to energy efficiency in the housing, building and industrial sectors, respectively. The Regulations prescribe a number of obligations for dealers who import into Canada or ship from one Canadian province to another any prescribed energy-using product. NRCan is committed to securing voluntary compliance but can use a range of enforcement measures, when necessary.

NRCan emphasizes self-monitoring, reporting, voluntary compliance and collaboration; however, enforcement measures can be used if dealers violate the law. Enforcement activities include preventing products that do not meet the prescribed energy efficiency standard from entering Canada and preventing the sale or lease of non-compliant product in Canada. Violators can be fined under the Canada Border Services Agency's Administrative Monetary Penalty System for not providing required information on the prescribed product at the time of import, and systematic violations can be prosecuted under the *Energy Efficiency Act*.

Key achievements for 2003-2004 with respect to compliance are as follows:

- Over 350 000 records relating to the importation into Canada were processed.
- Over 38 000 new or revised model numbers were entered into NRCan's compliance database from energy efficiency reports received from dealers.
- New processes to facilitate the updating of energy efficiency report submissions and to enable the processing of greater amounts of data in the database were implemented. New reporting forms were developed for regulated products to facilitate reporting of energy efficiency information by dealers and manufacturers. New batch import procedures were put in place to allow new energy efficiency data submissions to be processed more efficiently and in a timely manner. As a result of these improvements, the accuracy of the data that NRCan is capturing and the monitoring capabilities of the system increased.
- Dealer, manufacturer and importer communities were informed about new regulations affecting vented gas fireplaces in the Regulations.
- Instances of non-compliance were handled on a case-by-case basis in accordance with the Compliance Policy (the major activity being dealer, manufacturer and importer education of the requirements of the Regulations).

Chapter 2: Trends in Energy Use

Introduction

Canadians enjoy an abundance of energy from a variety of sources. This comparative advantage in the supply of energy helps Canadians deal with the economic disadvantages of small domestic markets, long distances, rugged geography and a relatively harsh climate. It also has favoured the development of industries that have a particularly strong energy demand.

Canadians spend almost $114 billion per year on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. This represents 10 percent of the country's gross domestic product (GDP).

Energy Use and Greenhouse Gas Emissions

There are two general types of energy use: primary and secondary. Primary energy use encompasses the total requirements for all users of energy, the energy required to transform one energy form to another (e.g. coal to electricity) and the energy used to bring energy supplies to the consumer. Secondary energy use is energy used by final consumers for residential, agricultural, commercial/institutional, industrial and transportation purposes.

Primary energy use in Canada today reflects changes over several decades in energy-consuming equipment and buildings and in the behaviour of energy users. Primary energy use increased by 21.5 percent between 1990 and 2002, from 9780 petajoules to 11 884 petajoules.

Secondary energy use (8217 petajoules) accounted for 69.1 percent of primary energy use in 2002. It was responsible for 66.2 percent (482 megatonnes) of total greenhouse gas (GHG) emissions in Canada, if indirect emissions – namely, those produced by electric utilities to meet end-use electrical demand – are included.

This report deals with energy-related GHG emissions, which comprise carbon dioxide (CO_2), methane and nitrous oxide. CO_2 represents the majority of Canada's GHG emissions. All subsequent references in this report to CO_2 and GHGs include emissions that are attributable directly to secondary energy use and indirect emissions attributable to electricity generation, unless otherwise specified.

From 1990 to 2002, secondary energy use increased 18.2 percent and related GHG emissions increased by 18.3 percent. The GHG intensity of energy changed slightly during the period as fuel switching towards less GHG-intensive fuels offset a higher GHG intensity in electricity production. The industrial sector is the largest energy user, accounting for 38.7 percent of total secondary energy use in 2002. The transportation sector is the second largest energy user at 28.1 percent, followed by the residential sector at 17.0 percent, the commercial/institutional sector at 13.8 percent and the agriculture sector at 2.5 percent.

Energy Intensity / Energy Efficiency

Aggregate energy intensity is the ratio of energy use per unit of GDP or, alternatively, energy use per capita. Aggregate energy intensity is sometimes used as a proxy for energy efficiency because it is simple, straightforward and the data for the calculation are readily available.

However this measure is misleading because, in addition to pure energy efficiency, intensity captures the impacts of weather variations and changes in the structure of the economy, among other things.

To properly gauge changes in energy efficiency over time, differences in economic structure and weather need to be normalized or factored out of the intensity calculation. Natural Resources Canada's (NRCan's) Office of Energy Efficiency (OEE) applies an internationally recognized factorization analysis technique to isolate the impact of energy efficiency on changes in Canadian energy use.

Figure 2-1 compares, for Canada, an index of annual variation in energy intensity with the OEE's index of changes in energy efficiency over the period 1990 to 2002. The indexes present improvements in energy intensity and efficiency as a downward trend.

TABLE 2-1

Energy Intensities for Selected IEA Countries

	GJ* per capita		GJ per $1,000 of GDP
Luxembourg	355.7	Czech Republic	18.8
Canada	249.2	Hungary	13.2
United States	225.6	Turkey	11.4
Finland	203.6	Canada	10.8
Norway	196.4	Korea	8.5
Belgium	175.4	New Zealand	8.1
Sweden	164.0	United States	7.2
Netherlands	157.3	Australia	6.5
Australia	157.0	Finland	6.3
New Zealand	149.3	Portugal	6.3

*Gigajoules

International Comparisons

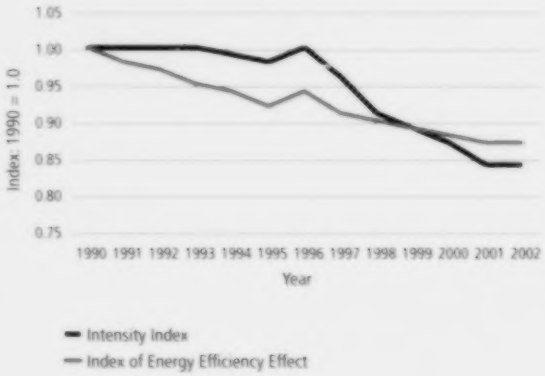
Canada has a higher aggregate intensity – absolute energy use per capita or per unit of GDP – than most International Energy Agency (IEA) countries, ranking second and fourth, respectively.

Meaningful comparisons of energy efficiency between countries can be difficult because very detailed energy, equipment stock, production and/or weather data for each target country are required.

However, according to a recent IEA report entitled *Oil Crises and Climate Challenges – 30 Years of Energy Use in IEA Countries*, Canada's energy efficiency improved at an average annual rate of 1 percent between 1990 and 1998, similar to the rate recorded by the United States, and the fourth fastest rate of improvement among the 13 countries included in the report (surpassed by Finland, Italy and Norway).

FIGURE 2-1

Canada: Changes in Energy Intensity and the Energy Efficiency Effect, 1990–2002



Trends in Energy Efficiency

NRCan annually publishes *Energy Efficiency Trends in Canada*, which reports on changes in energy use (and GHG emissions) and the contribution of the following key factors to these changes:

- Increases in sector **activity** lead to increased energy use and emissions. In the residential sector, for example, an increase in the number of households results in increased energy use.
- Fluctuations in **weather** lead to changes in space-heating and space-cooling requirements. A colder winter or a warmer summer can lead to increased energy use.
- A shift in the **structure** of activity toward more energy-intensive components of activity leads to increased energy use and emissions. For example, if the distribution of activity in the industrial sector shifts from forestry to the iron and steel industry, industrial energy use will increase because the former sector is less energy intensive than the latter.
- A higher **service level** for end-uses such as auxiliary equipment (e.g. computers, fax machines and photocopiers) and air conditioning increased energy use and emissions. This factor is only applied to commercial/institutional buildings. During the 1990s, these types of equipment were widely adopted; however, improvements in functionality increased productivity and moderated increases in energy consumption due to the use of more machines.
- Improvements in **energy efficiency** result in less energy being consumed, for example, how long an appliance can be operated with a given amount of energy.

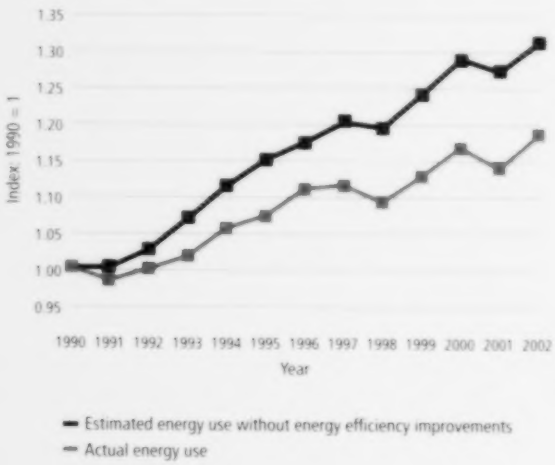
In this report, changes in energy efficiency are the net result after allowing for the changes in energy use due to changes in activity, weather, structure and service level. To the extent that other factors that affect energy use have not been captured, this measure of energy efficiency improvement might overstate or understate the "actual" change. For example, in the industrial sector, there may have been changes in energy use due to shifts in the mix of products, but this is not captured.

Secondary energy use increased between 1990 and 2002 (from 6950 to 8217 petajoules). Without improvements in energy efficiency, increases attributable to activity, weather, structure and service level would have led to an increase in secondary energy use of 30.9 percent. However, as a result of a 12.7 percent (881 petajoules) improvement in energy efficiency, actual secondary energy use increased by 18.2 percent (8217 petajoules).

The change in energy use between 1990 and 2002, actual and without energy efficiency improvements, is shown in Figure 2-2. The difference in energy use due to energy efficiency – the estimated energy saving – represents a reduction in energy costs of $11.6 billion in 2002 and a reduction in GHG emissions of almost 50 megatonnes. Changes in energy efficiency are estimated for each of the four major end-use sectors and are presented in Chapters 4 to 7. The energy efficiency improvements were largest in the residential sector (19.8 percent), followed by the industrial sector (14.2 percent), transportation sector (9.9 percent) and commercial/institutional sector (7.3 percent).[1]

FIGURE 2-2

Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002



[1] The aggregate energy-use data presented in this report are taken from Statistics Canada's *Report on Energy Supply-Demand in Canada* (RESD). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of RESD energy use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*, whereas this report uses a definition better suited for energy end-use analysis. Some modifications to the original Statistics Canada data were required and are documented in Appendix A of Natural Resources Canada's *Energy Use Data Handbook, 1990 and 1996 to 2002*.

TABLE 2-2

Explanation of Changes in Secondary Energy Use, 1990 to 2002

	Sectors						
	Residential	Commercial/ Institutional	Industrial	Transportation	Agriculture	Total	% Change
1990 energy use (PJ)	1288.9	867.0	2717.4	1877.9	199.2	6950.4	
2002 energy use (PJ)	1399.4	1130.1	3176.1	2306.0	205.7	8217.2	
Change in energy use (PJ)	110.4	263.1	458.6	428.1	6.5	1266.8	18.2%
Explanatory Factor (change due to)							
Activity	302.0	231.0	1182.5	411.7		2127.2	30.6%
Weather	21.4	26.5	n/a	n/a		47.9	0.7%
Structure	41.8	11.4	-337.9	165.3		-119.4	-1.7%
Service level	n/a	57.7	n/a	n/a		57.7	0.8%
Energy efficiency	-254.8	-62.3	-386.0	-177.6		-880.7	-12.7%
Other factors		-1.1		28.7	6.5	34.1	0.5%

Trends in Renewable Energy

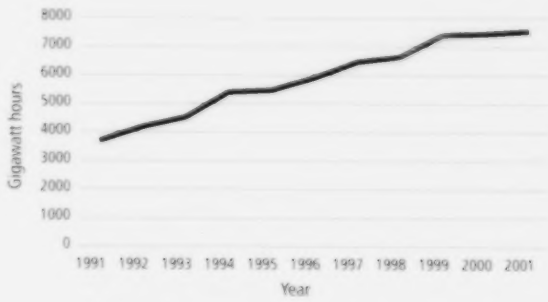
Although in the near term this can be achieved by moving from more to less GHG-intensive fuels (e.g. from coal to natural gas), over the longer term the use of renewable energy sources is expected to accelerate this trend.

Figure 2-3 shows the trend in the use in Canada of electricity generated from wind, solar and biomass, indicating a 204 percent increase over 1991–2001. Although representing only a small component of overall electricity use, the proportion of electricity generated from these renewable energy sources increased from 0.75 percent to 1.32 percent over the period, representing a 57 percent increase in its share. Most of this production was derived from biomass.

The graph does not include hydro sources, either conventional or small (less than 20 megawatts). The former accounts for about 60 percent of electricity generated in Canada; installed capacity is over 62 gigawatts. There are over 230 small hydro installations in Canada, with a total capacity of about 1500 megawatts.

FIGURE 2-3

Electricity Production From Renewable Sources



Chapter 3: Measuring Progress

Introduction

The primary goal of Natural Resources Canada's (NRCan's) efficiency and alternative energy initiatives is to change energy consumption patterns to obtain environmental and economic benefits. Part of assessing program progress and performance involves considering both program delivery and program effectiveness.

In the past, NRCan has focused on the monitoring and tracking of the following three aspects of program delivery:

- program outputs
- program outcomes
- market outcomes

Program outputs are the items produced regularly, such as information and marketing materials, demonstration projects, financial incentives and regulations. Program outputs are designed to lead to **program outcomes** – namely, changes in the behaviour of groups targeted by a program. These groups may be either energy users or producers of energy-using equipment or structures. For example, program outcomes occur when consumers purchase more energy-efficient appliances than they would have if there were no program. Other important factors that influence consumer behaviour include product price, household income, personal taste and other government and non-government programs.

Since program outcomes can directly affect the amount and type of energy consumed in the market, they contribute, in part, to observable **market outcomes**. Market outcomes ultimately reflect the impacts of NRCan programs on changes in energy efficiency, energy intensity, greenhouse gas (GHG) emissions and the use of alternative energy. In this sense, achievement of a targeted market outcome, or observable progress towards a market outcome, serves as an indicator of program effectiveness. An example of a program outcome that leads to a market outcome is a householder's purchase of a more energy-efficient appliance and reduced use of electricity. Depending on the source of electricity and how the utility changes its electricity-generating methods to meet the change in demand that results from reduced electricity use, this could also lead to a decline in GHG emissions.

Focusing on Results

The government-wide initiative aimed at "managing for results" has encouraged management in all federal departments and agencies to focus more on the impacts and effects of their programs and services on the lives of Canadians. Managing for results requires more than just the monitoring of program delivery; it means clearly defining the results to be achieved, increasing the emphasis on program and market outcomes, measuring and evaluating program performance, and making adjustments to improve both the efficiency and effectiveness of programs. It also means reporting on performance in ways that make sense to Canadians.

This report uses a mix of progress indicators, which are quantitative where possible. The challenge for NRCan is to continuously improve the coverage and quality of these progress indicators, both in general and in order to ensure that they increasingly reflect a focus on results. The following section highlights some of NRCan's efforts to improve the quality of its program performance information through better data collection and data analysis.

Data Collection and Analysis

In 1991, NRCan launched the National Energy Use Database (NEUD) initiative to help the department improve its knowledge of energy consumption and energy efficiency at the end-use level in Canada, and to support NRCan's analytical expertise. The NEUD initiative plays a number of crucial roles directly related to NRCan program activities; however, its most important roles are to secure the development of a reliable, Canada-wide information base on energy consumption at the end-use level for all energy-consuming sectors, and to perform analyses related to energy efficiency program performances.

The NEUD initiative consists of several broad components that typically involve conducting large- and small-scale surveys of the stocks and characteristics of energy-using equipment and buildings, observing consumer behaviour with respect to energy use, monitoring the adoption of new technologies in the market place and participating in the development of energy end-use data and analysis centres (DACs) across Canada.

The main objective of the DACs is to create a base of expertise for the analysis of energy consumption at the end-use level in Canada. The DACs are mandated to improve the accessibility and comparability of existing data on the evolution of energy consumption and its impact on environmental quality. Three DACs currently exist: the transportation centre at Université Laval in Québec City, Quebec; the industrial centre at Simon Fraser University in Burnaby, British Columbia; and the buildings centre at University of Alberta in Edmonton, Alberta.

The centres have made significant contributions to NEUD's mandate of improving knowledge of energy consumption and energy efficiency at the end-use level in Canada. For example, in 2003–2004, the transportation centre at Université Laval, using a discrete choice model, conducted an analysis on the impact of the EnerGuide sticker for new vehicles on consumers' purchase behaviour.

Chapter 4: Housing

Energy Use and Greenhouse Gas Emissions

The residential sector includes four major types of dwellings: single detached, single attached, apartments and mobile homes. Energy is used in dwellings for space heating and cooling, heating water, and operating appliances, electronic equipment and lights. This sector accounts for 17 percent (1399 petajoules) of secondary energy use and 15.6 percent (75 megatonnes) of greenhouse gas (GHG) emissions.

Most dwellings in Canada are single detached houses, followed by apartments, single attached dwellings and mobile homes (see Figure 4-1). Because single detached and attached houses predominate, most Natural Resources Canada (NRCan) residential building programs focus on these types of dwellings.

Space and water heating make up 81 percent of residential energy use, followed by the shares devoted to operating appliances, lighting and space cooling (see Figure 4-2).

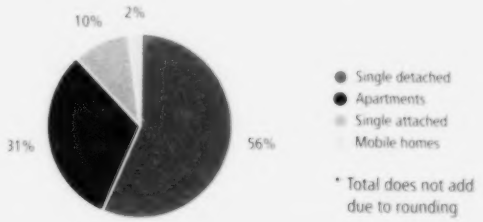
Between 1990 and 2002, residential energy use increased by 8.6 percent, or 110 petajoules (from 1289 to 1399 petajoules). From 1990 to 2002, GHG emissions from the residential sector increased by 8.4 percent. GHG intensity changed little because fuel switching towards less GHG-intensive fuels offset an increase in the GHG intensity of electricity production over the period.

Four main factors tended to influence residential energy use – activity, weather, structure and energy efficiency:

- activity – the increase in the number of households and the size of dwellings (the principal measures of residential activity) increased energy use by 23.4 percent (302 petajoules)
- weather – a colder winter and a warmer summer in 2002 compared with 1990 led to an increase in space-conditioning requirement; this increased energy use by 1.7 percent (21 petajoules)
- structure – the percentage shares of energy end-uses changed over the period such that they increased energy use by 3.2 percent (42 petajoules)
- energy efficiency – improvements in energy efficiency decreased energy use by 19.8 percent (255 petajoules)

FIGURE 4-1

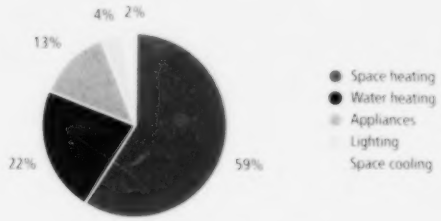
Canadian Households by Type of Dwelling, 2002*



* Total does not add due to rounding

FIGURE 4-2

Residential Energy Use by Purpose, 2002



Growth in residential energy use was driven in large part by growth in activity. This increase was partially offset by significant improvements in energy efficiency. Structural changes had a minor impact on residential energy use.

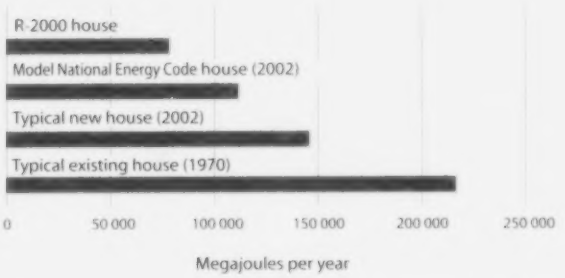
The change in overall residential energy use from the years 1990 to 2002, as well as the estimated energy savings due to energy efficiency, is shown in Figure 4-3. Figures 4-4 and 4-5 show how energy consumption differs for houses built to different standards and in different periods, reflecting improvements in building construction.

NRCan delivers initiatives to increase energy efficiency in the following residential sub-sectors:

- new houses
- existing houses
- residential equipment

FIGURE 4-4

EnerGuide Rating for Houses Annual Heating Consumption for Houses* Constructed to Different Standards



* 198-m² one-storey, single detached house heated with natural gas, Ottawa, Ontario

Figure 4-3

Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

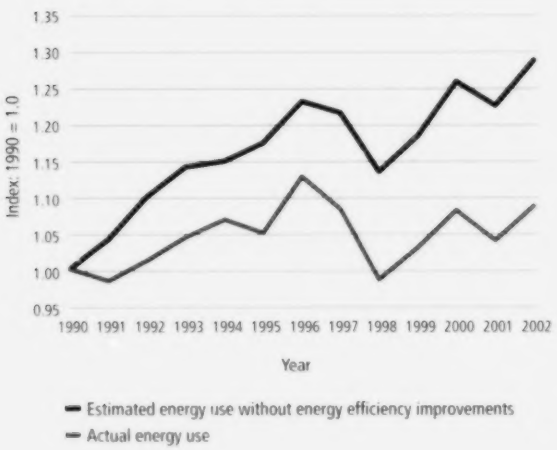
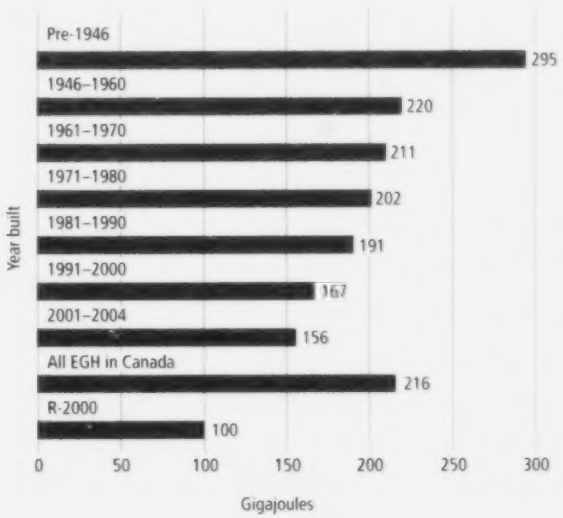


FIGURE 4-5

Average Energy Consumption per Household*, Pre-1946 to 2001–2004



* From R-2000 and EnerGuide for Houses programs

New Houses: **R-2000 Standard and EnerGuide for (New) Houses**

Objective: To increase market adoption of energy-efficient new houses by promoting changes in construction practices and by labelling houses for energy performance.

The R-2000 Standard is a voluntary technical performance standard that encourages Canadian builders to build, and Canadian consumers to purchase, houses that are more energy efficient and environmentally responsible than is required by current Canadian building codes. NRCan trains and licenses R-2000 homebuilders and other professionals in R-2000 Standard construction techniques and practices, and provides third-party quality assurance by testing and certifying R-2000 homes.

EnerGuide for (New) Houses is an energy-performance rating and labelling scheme designed to encourage the industry to build, and consumers to purchase, more energy-efficient houses. The EnerGuide for Houses (EGH) scheme is based on the R-2000 Standard and training, and it targets large-volume, mass-market builders.

Key 2003–2004 Achievements

- Over 1000 industry professionals received training in R-2000 construction techniques and the sizing and installation of high-efficiency heating and ventilation systems.
- EnerGuide for (New) Houses rating scheme was launched and has been chosen for inclusion in Built Green™ Alberta and Manitoba Power Smart house initiatives.
- Successfully launched the Building Canada initiative, aimed at recruiting and training key, very large-volume builders to construct and EGH-label energy-efficient houses.

For more information:
oee.nrcan.gc.ca/r-2000/english/index.cfm

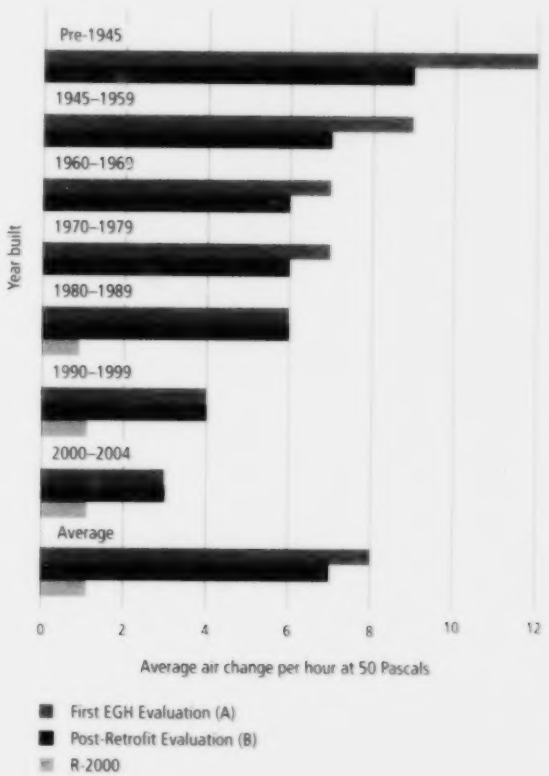
R-2000 is an official mark of Natural Resources Canada.

FIGURE 4-6

Number of Eligible R-2000 Housing Starts, 1990 to 2003

FIGURE 4-7

National Trends in Air Leakage (R-2000 and EnerGuide for Houses), Pre-1945 to 2000–2004



New Houses: **Super E™ House Program**

Objective: To build capacity for exporting energy-efficient, durable and environmentally friendly Canadian housing technology to foreign markets.

The Super E™ House Program is a strategic housing export initiative delivered by NRCan as part of the Team Canada export strategy. The program adapts internationally leading Canadian energy efficiency standards to foreign markets and identifies appropriate technologies for them, to create unique market opportunities for Canadian housing technology companies. Launched in 1998, the Super E House Program has facilitated partnerships between Canadian builders and their foreign counterparts to increase market penetration of Canadian energy-efficient technologies internationally.

The Super E U.K. program is financed by the CANMET Energy Technology Centre (CETC), the Canada Mortgage and Housing Corporation (CMHC) and the Canadian Forest Service (CFS). The Super E Japanese program is financed by CETC and CMHC. In both cases, there is strong support from the Department of Foreign Affairs and International Trade (now divided into Foreign Affairs Canada and International Trade Canada). The Super E U.K. Industry Consortium now comprises 11 Canadian and 15 U.K./Irish companies, and the Super E Japan program comprises 13 Canadian companies and 25 Japanese partners.

The Super E U.K. program has registered 92 units completed, generating $9.2 million of revenue to Canadian companies with confirmed Super E orders of 43 additional units valuing at $4.3 million. The Super E Japan program has registered 91 units completed, generating $7 million of revenue to Canadian companies. In both countries, Super E is now established as high quality housing uniquely available from Canada and its exporters.

Key 2003–2004 Achievements

- Established a not-for-profit organization, the Energy Efficient Exporters Alliance, to administer and represent industry interests for the Super E House Program.
- Secured major funding until 2007 from the CFS through the Canada Wood Export Program to continue to promote and develop the market in the U.K. for Super E.
- Signed new Super E agreements and house openings in London, U.K., presided over by CMHC Secretary of State.
- Secured a Super E Project in China (by CMHC).

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

Super E is an official mark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

Existing Houses: **EnerGuide for Houses and Retrofit Incentives**

Objective: To encourage Canadians to improve the energy efficiency of their homes.

EnerGuide for Houses (EGH) provides Canadian homeowners with personalized expert advice on how to best improve the energy performance of their houses, especially when undertaking renovation and maintenance projects. Under EGH, a retrofit incentive was officially launched in October 2003. Homeowners can now qualify for a non-taxable grant, which represents about 10 to 20 percent of their expenditures, when they retrofit their homes. The grant is based on the differential improvement in the house's energy rating, as measured by a pre- and post-renovation EGH energy evaluation.

Key 2003–2004 Achievements

- Over 48 000 houses evaluated and labelled.
- Issued 2145 grants, totalling $1.3 million. These grants were paid to homeowners between the October 2003 launch and the end of the fiscal year. Grants are currently being paid in under 60 days.
- Reduced energy consumption by between 20 and 38 percent in post-retrofit homes; grant recipients reduced carbon dioxide (CO_2) by an average of 4 tonnes per year, per house.

For more information:
oee.nrcan.gc.ca/residential/personal/index.cfm

FIGURE 4-8

Evaluations Under EnerGuide for Houses, 1998–1999 to 2003–2004

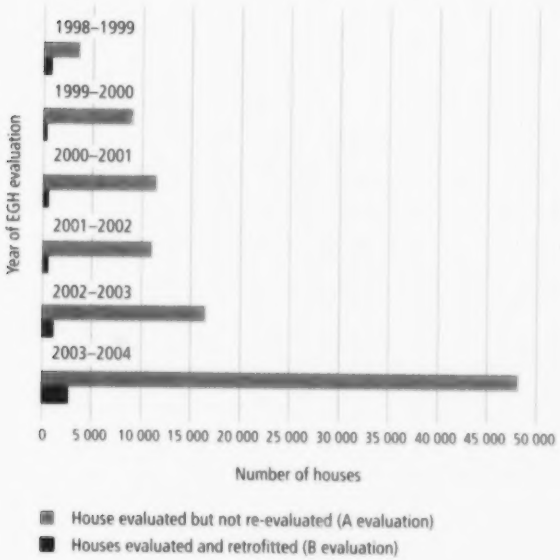
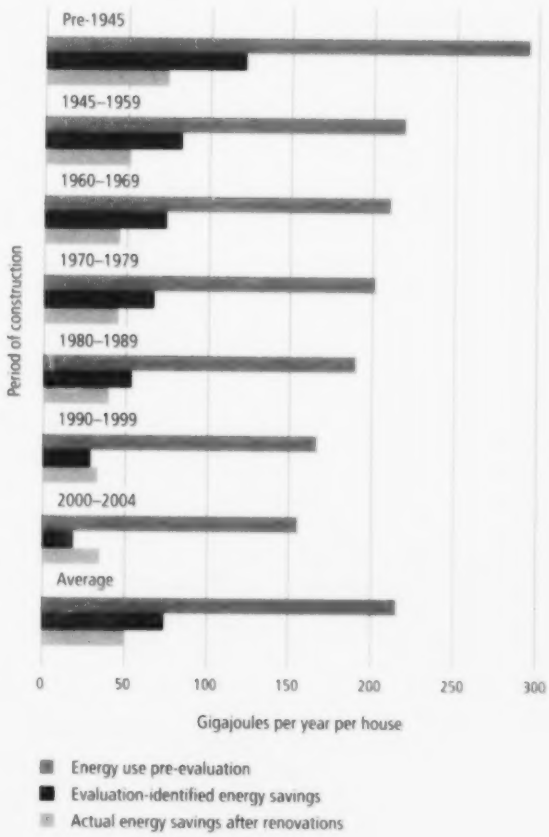


FIGURE 4-9

Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2004



Residential Equipment: **Energy Efficiency Standards and Regulations**

Objective: To eliminate the less energy-efficient models of energy-using equipment from the market through minimum performance regulations under the *Energy Efficiency Act*.

The *Energy Efficiency Regulations* incorporate national consensus performance standards that include testing procedures to determine the energy performance of the equipment. They prohibit imports of, or interprovincial trade in, prescribed products that fail to meet minimum energy-performance levels and labelling requirements.

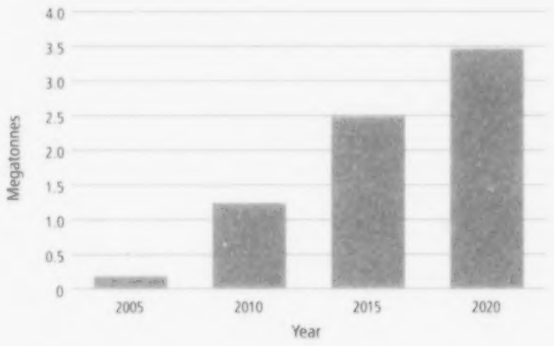
Key 2003–2004 Achievements

- Pre-published eighth amendment to the *Energy Efficiency Regulations* to increase the minimum energy performance standards in the residential sector for clothes washers and gas-fired and electric storage water heaters. Estimated reductions in CO_2 emissions in the residential sector from this amendment are shown in Figure 4-10.
- The cumulative annual reductions in CO_2 emissions resulting from the aggregate energy savings attributable to the eighth amendment to the *Energy Efficiency Regulations* in the residential sector are estimated to be approximately 0.17 megatonnes in the year 2005 and 3.44 megatonnes in the year 2020.

For more information:
oee.nrcan.gc.ca/regulations/home_page.cfm

FIGURE 4-10

Eighth Amendment: Estimated Reductions in CO_2 Emissions, 2005 to 2020



Residential Equipment: Labelling and Promotion

Objective: To promote the production, purchase and use of more energy-efficient equipment.

The Labelling and Promotion Initiative consists of labelling, rating and promotional activities that encourage manufacturers to produce, and consumers to purchase, more efficient energy-using equipment. The initiative consists of EnerGuide for Equipment, which provides comparative information on the energy performance of major household appliances as well as heating, ventilating and air-conditioning (HVAC) equipment, and the administration in Canada of the international ENERGY STAR® label, which allows the consumer to identify the most energy-efficient products available based on a standard set of criteria. Activities range from ensuring that ENERGY STAR® products are well-identified and available for Canadians to buy, to promoting the symbol in catalogues and Web sites, to developing specific initiatives around ENERGY STAR® qualified products.

Key 2003–2004 Achievements

- Newspaper articles featuring EnerGuide had the second largest pick-up in national and community newspapers.
- Implemented Canada-specific ENERGY STAR® criteria for windows and sliding glass doors sold in Canada.
- Recruited over 140 organizations to participate in and promote ENERGY STAR® in Canada. Many retailers across Canada, including Sears Canada Inc., the Hudson's Bay Company and The Home Depot, Inc. have featured ENERGY STAR® products in their flyers. Specifically, Home Depot has organized retail activities promoting its ENERGY STAR® qualified products, entitled "EnergyWise – Au Courant."
- Use of the ENERGY STAR® high efficiency levels by provinces and utilities as the qualifying level for rebates and incentives. Specifically, Saskatchewan and Ontario have used ENERGY STAR® to qualify high efficiency appliances for provincial sales tax rebates.
- Many gas utilities – Terasen Inc. in British Columbia, SaskEnergy Incorporated in Saskatchewan, Union Gas Limited and Enbridge Gas Distribution in Ontario, Heritage Gas Limited in Nova Scotia and Enbridge Gas New Brunswick in New Brunswick – have specified the ENERGY STAR® high efficiency level for incentives for gas furnaces and boilers. Climate Change Central in Alberta also used the ENERGY STAR® levels to qualify for rebates on high efficiency gas furnaces and boilers. In all, approximately 18 000 new gas furnaces and boilers qualifying for ENERGY STAR® have included incentives or rebates from these programs across Canada. Projects with Terasen and Union Gas have additionally included a rebate to encourage the installation of high efficiency gas furnaces with variable speed, high efficiency fan motors, which addresses the electricity consumption portion of these appliances. SaskEnergy has set up an ENERGY STAR® Loan Program where consumers who purchase ENERGY STAR® qualified gas heating systems would get zero percent financing. The province of New Brunswick announced that government procurement practices include specifying ENERGY STAR® qualified products where feasible and practical.

For more information:
energuide.gc.ca
oee.nrcan.gc.ca/equipment
energystar.gc.ca

FIGURE 4-11

ENERGY STAR® Label

FIGURE 4-12

Average Energy Consumption of New Appliances, 1990 and 2002 Models

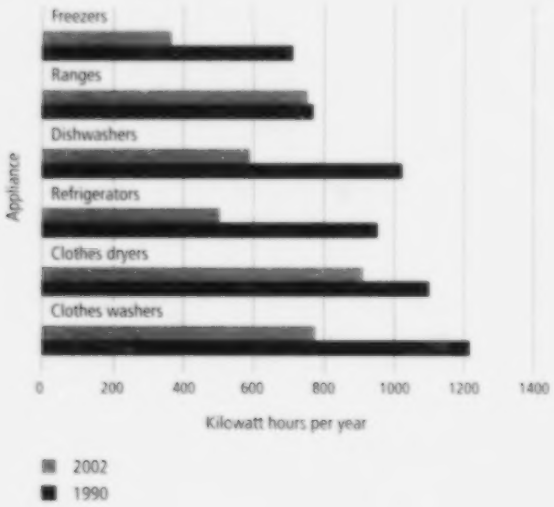


FIGURE 4-13

Unit Energy Consumption for Top-Mounted Auto-Defrost Refrigerators Marketed in Canada, 1991 and 2004 Models

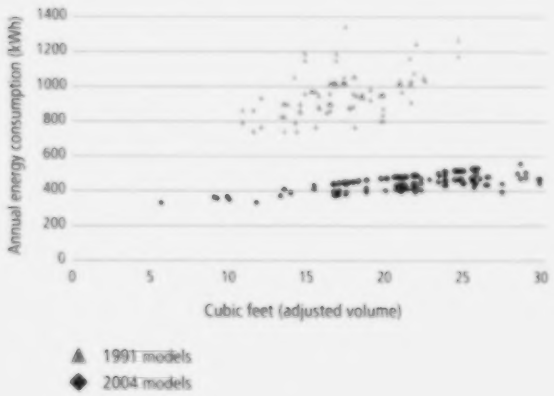
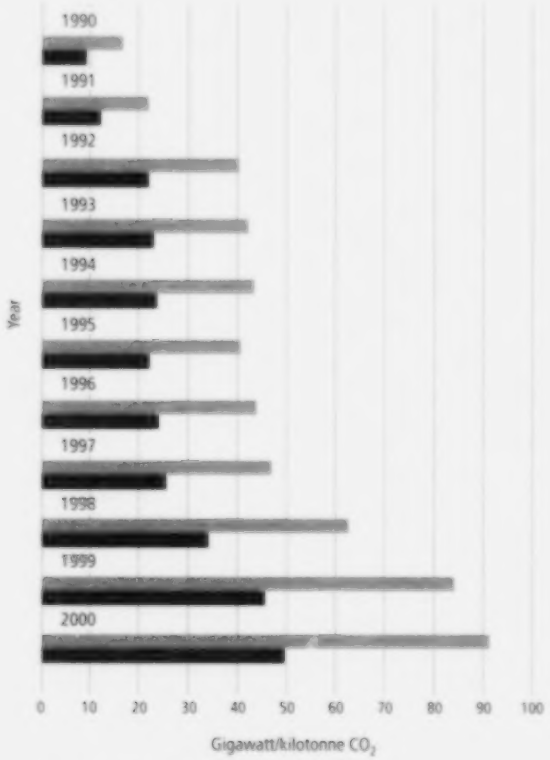


FIGURE 4-14

Impact of EnerGuide Labelling: Total Energy Savings and GHG Emissions Reductions Attributable to the EnerGuide for Equipment Program, 1990 to 2000



Residential Equipment: **Housing Energy Technology Program**

Objective: To accelerate the development and market adoption of energy-efficient housing technologies.

Working in partnership with associations, government and industry, the CANMET Energy Technology Centre (CETC) manages this program to develop and deploy highly specialized solutions that help reduce, in a cost-effective manner, the energy consumption and GHG emissions of Canadian houses. Progress to date includes the identification, accelerated development and broader deployment of a number of promising technologies, such as advanced integrated mechanical systems (now trademarked ēKOCOMFORT™) and electronically commutated motors.

In whole house design, the development and technical support of the R-2000 Standard has led to extensive technology development and deployment throughout the housing sector. Through its associated Building Energy Simulation Program, CETC's software tools are widely used to assess the energy use in a home. CETC also develops more energy-efficient frames for windows and is a lead managing agency for the Canadian Centre for Housing Technology (CCHT), an advanced testing facility for assessing whole-house impacts of emerging technologies.

Key 2003–2004 Achievements

- Signed an agreement with a leading Canadian fuel cell developer to test a beta residential fuel cell in a joint project at CCHT. This will be the first residential fuel cell installation in Canada.
- Tested and assessed a distributed generation combined heat and power (CHP) system based on a Stirling engine that was integrated into the heating and electrical systems at CCHT. The system showed good potential for Canadian housing and will be further investigated in 2004–2005.
- Continued to work with the Canadian Standards Association (CSA) to develop a new residential integrated mechanical systems standard based on the test protocol developed by CETC for the ēKOCOMFORT consortium. The Standard will enable the efficiency of integrated products to be recognized and certified.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

ēKOCOMFORT is a Trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

Chapter 5: Buildings

Energy Use and Greenhouse Gas Emissions

The commercial/institutional sector includes activity related to trade, finance, real estate, public administration, education and commercial services, including tourism. This sector uses energy mainly for space and water heating, space cooling, lighting, motive power for services such as pumping and ventilation in buildings, and street lighting.

In 2002, the total commercial/institutional sector accounted for 13.8 percent (1131 petajoules) of secondary energy use and 13.4 percent (64.4 megatonnes) of greenhouse gas (GHG) emissions.

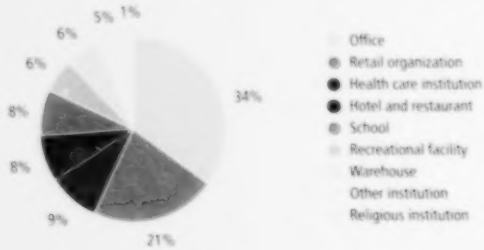
To highlight energy use in buildings, the following analysis excludes energy use for street lighting. The commercial/institutional sector comprises many building types (see Figure 5-1). Retail and office space account for more than half of commercial/institutional sector energy demand. Health care institutions, hotels and restaurants and schools account for another 25 percent of that demand. Natural Resources Canada's (NRCan's) initiatives address all of these major energy-using building types.

Energy is used for six purposes in commercial/institutional buildings. The largest of these is space heating, which accounts for more than half of energy use in this sector (see Figure 5-2). Each of the remaining five uses of energy accounts for between 6 and 13 percent of energy demand in this sector.

Between 1990 and 2002, commercial/institutional energy use, excluding street lighting, increased by 30.8 percent, or 264 petajoules (from 858 to 1122 petajoules). However, GHG emissions from the sector rose by 35.1 percent in the same period. Emissions increased more quickly than energy use due to the increased use of energy sources with a higher GHG content.

FIGURE 5-1

Commercial/Institutional Energy Use by Building Type*, 2002



* Excludes street lighting

FIGURE 5-2

Commercial/Institutional Energy Use by Purpose*, 2002

* Excludes street lighting

Figure 5-3

Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

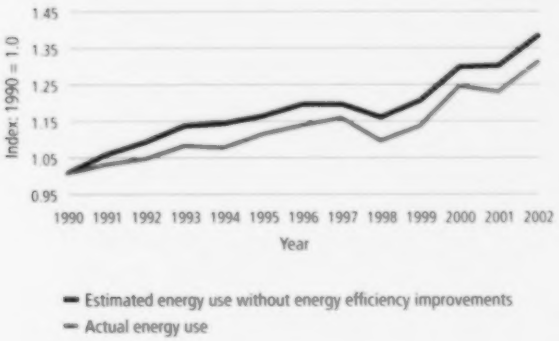
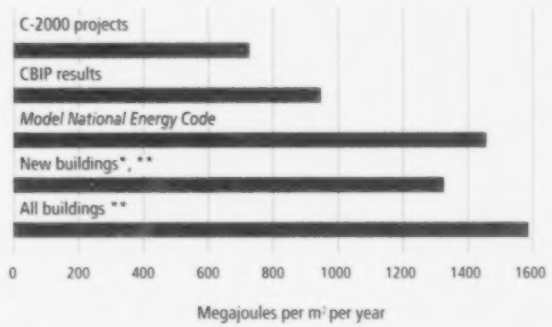


FIGURE 5-4

Energy Use in Commercial Buildings, 2000


C-2000 projects
CBIP results
Model National Energy Code
New buildings*, **
All buildings **
0 200 400 600 800 1000 1200 1400 1600
Megajoules per m² per year

* 1990–2000

** Source: Commerical and Institutional Building Energy Use Survey, 2000. Estimates relate only to the surveyed area of populations over 175 000, and in Atlantic Canada to populations over 50 000.

During 1990–2002, a steady increase in activity largely contributed to increased energy use. To a lesser degree, service levels for auxiliary equipment and space cooling, structure (the mix of building types) and weather also each played a role. However, energy efficiency slowed this rate of increase. Specifically, the energy use changes attributed to each of these factors are

- activity – a 26 percent increase in activity resulted in a 231-petajoule increase in energy use
- weather – fluctuations in weather resulted in a 3.1 percent increase in energy use (26 petajoules)
- structure – a shift in activity resulted in a 1.3 percent increase in energy use (11 petajoules)
- service level – a higher service level for end-users resulted in a 6.7 percent increase in energy use (58 petajoules)
- energy efficiency – a 7.3 percent improvement in energy efficiency resulted in a decrease of 62 petajoules

Without improvements in energy efficiency, increases attributable to activity, weather, structure and service level would have led to an increase in commercial/institutional energy use of 38.1 percent (327 petajoules). However, as a result of a 7.3 percent improvement in energy efficiency, actual energy use increased by 30.8 percent. This change in energy use during 1990–2002, as well as the estimated energy savings due to energy efficiency, is shown in Figure 5-3. Figure 5-4 shows how energy use in commercial buildings compares to certain standards.

NRCan delivers initiatives to increase energy efficiency in the following sub-sectors of the commercial/institutional sector:

- new buildings
- existing buildings
- equipment

New Buildings: **Commercial Building Incentive Program**

Objective: To improve the energy efficiency of new commercial, institutional and multi-unit residential buildings.

The Commercial Building Incentive Program (CBIP) provides financial incentives to builders and developers who incorporate energy-efficient features into the design and construction of new commercial, institutional and multi-unit residential buildings. To qualify for the incentive, buildings must be at least 25 percent more energy efficient than similar buildings constructed to the *Model National Energy Code for Buildings* (MNECB). However, results indicate that CBIP buildings are on average 35 percent better than similar buildings constructed to the MNECB. The program is delivered by the Government of Canada and co-marketed by a number of provincial/territorial utilities, provincial/territorial energy efficiency and climate change agencies, and building professional organizations.

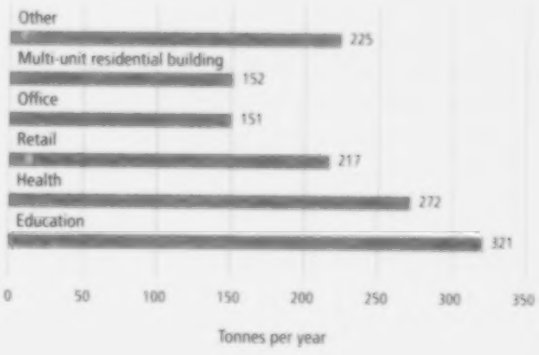
Key 2003–2004 Achievements

- New partnerships formed with Climate Change Central (Alberta) and Gazifère (Quebec). Ongoing partnerships with Enbridge Gas Distribution (Ontario), Gaz Métro (Quebec) and Manitoba Hydro.
- Incentives given to 372 projects since program inception. As a result, 78 kilotonnes of GHG emissions have been avoided.
- CBIP buildings average 34.8 percent more energy efficiency than similar buildings constructed to the MNECB.

For more information:
oee.nrcan.gc.ca/newbuildings

FIGURE 5-5

Estimated Average GHG Reductions by Institution Under CBIP, 2003 to 2004



New Buildings: **Industrial Building Incentive Program**

Objective: To improve the energy efficiency of new industrial buildings.

The Industrial Building Incentive Program (IBIP) extends the precepts of CBIP to the industrial sector. IBIP offers an incentive to companies building new energy-efficient industrial facilities to offset additional design costs inherent in the initial attempts at energy-efficient designs and building/process integration. The design is assessed against a reference generated from the MNECB.

Key 2003–2004 Achievements

- Six contribution agreements were signed; three of these were for laboratories.
- Seventeen projects provided incentives since program inception.
- Seventeen architects and engineers were trained for energy-efficient industrial building design.
- Modelling guidelines for industrial buildings were completed.
- One design charrette for a printing plant was completed.

For more information:
oee.nrcan.gc.ca/newbuildings

New Buildings: **Green Buildings Program**

Objective: To reduce energy use, resource consumption and emissions from commercial buildings through design, construction and retrofitting while increasing cost-effectiveness.

The program plays a significant role in establishing goals for energy efficiency and sustainability in commercial buildings through a variety of key activities. Through the C-2000 Program for Advanced Commercial Buildings – a small demonstration program for high-performance buildings – NRCan sets targets for designers to reduce energy consumption by 50 percent and water consumption by 40 percent. It provides the necessary tools, guidelines and techniques through its integrated design process (IDP) to lead design teams to produce optimized, energy-efficient, integrated building designs that fully exploit building component synergies.

The program also provides ongoing support to NRCan programs such as CBIP by developing guidelines, providing technical support and developing downloadable simulation software tools that perform accurate building analysis, assist in design and measure compliance with these incentive programs.

NRCan launched the Green Building Challenge (GBC) in 1996 (now managed by a third party) and established Sustainable Building (SB) conferences to showcase the results and best practices of the competing energy-efficient buildings. GBC brings together more than 20 countries focused on the development and testing of an internationally accepted system for assessing the environmental performance of buildings. The NRCan-developed electronic GBTool™ is used in the assessments.

Key 2003–2004 Achievements

- Award-winning C-2000 building at Red River College, Winnipeg, was featured on the front cover of *Canadian Architect* magazine, highlighting the largest building designed and built under CANMET Energy Technology Centre's (CETC's) C-2000 Program and also the first major adaptive re-use of heritage buildings.
- CETC continued to build capacity for energy-efficient building design by integrating C-2000, the IDP and energy software tools into university/college architecture and building science curricula, as well as through seminars given at the largest construction trade show in Canada (Construct Canada) and by working with municipalities in Alberta and Manitoba and the city of Ottawa.
- The SB'05 Canadian Team was established and Canadian buildings are currently being reviewed and selected for assessments to be presented at the 2005 conference.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

GBTool is a Trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

Existing Buildings: **Energy Innovators Initiative**

Objective: To encourage commercial businesses and public institutions to become more energy efficient and reduce their GHG emissions that contribute to climate change.

The Energy Innovators Initiative (EII) helps commercial organizations and public institutions explore energy efficiency options and strategies, offering them access to tools and financial assistance to help reduce energy costs and improve competitiveness. Members join the EII by sending a letter to the Minister of Natural Resources from senior management stating their commitment to energy efficiency. Currently, over 1600 commercial, institutional and multi-unit residential organizations across Canada are Energy Innovators.

After joining the EII, members can apply for Energy Retrofit Assistance (ERA) funding for retrofit planning activities and retrofit implementation projects in existing commercial/institutional buildings.

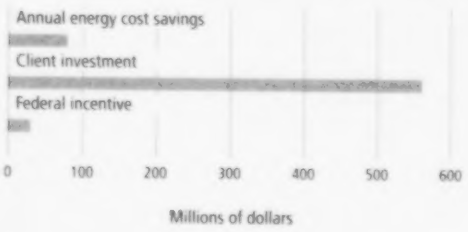
Key 2003–2004 Achievements

- Expanded program to allow more organizations to apply for funding.
- Established 13 formal partnerships with member-based associations through contribution agreements.
- Funded approximately 70 energy retrofit implementation projects and more than 205 retrofit planning activities.

For more information:
oee.nrcan.gc.ca/eii/home.cfm

FIGURE 5-6

Energy Innovators Initiative – Incentive Projects, 1998 to 2004



Equipment: **Energy Efficiency Standards and Regulations**

Objective: To eliminate the less energy-efficient models of energy-using equipment from the market through minimum performance regulations under the *Energy Efficiency Act*.

The *Energy Efficiency Regulations* incorporate national consensus performance standards that include testing procedures to determine the energy performance of the equipment. They prohibit imports of, or inter-provincial trade in, prescribed products that fail to meet minimum energy-performance levels and labelling requirements.

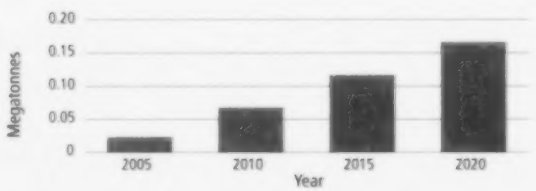
Key 2003–2004 Achievements

- Pre-published eighth amendment to the *Energy Efficiency Regulations* to establish minimum energy performance standards in the commercial sector for water chillers and exit signs. Estimated reductions in carbon dioxide (CO_2) emissions in the commercial sector from this amendment are shown in Figure 5-7.
- The cumulative annual reductions in CO_2 emissions resulting from the aggregate energy savings caused by the eighth amendment to the *Energy Efficiency Regulations* in the commercial sector are estimated to be approximately 0.02 megatonnes in the year 2005 and 0.17 megatonnes in the year 2020.

For more information:
oee.nrcan.gc.ca/regulations/home_page.cfm

FIGURE 5-7

Eighth Amendment: Estimated Reduction in CO_2 Emissions, 2005 to 2020



Equipment: **Labelling and Promotion**

Objective: To promote the production, purchase and use of more energy-efficient equipment.

The initiative includes EnerGuide for Equipment, which provides comparative information on the energy performance of equipment – including heating, ventilating and air conditioning (HVAC) – and the international ENERGY STAR® label, which allows the consumer to identify the most energy-efficient products available based on a standard set of criteria.

Key 2003–2004 Achievements

- Advertising strategy for gas fireplaces developed to inform consumers about EnerGuide.
- Appliance and room air directories published and sent to major retailers.
- ENERGY STAR® retail brochure produced and distributed.

For more information:
energuide.nrcan.gc.ca
oee.nrcan.gc.ca/equipment
energystar.gc.ca

Equipment: **Buildings Program – Refrigeration Systems Equipment**

Objective: To support the development and the adoption of innovative refrigeration technologies that reduce energy consumption, synthetic refrigerant use and GHG emissions in commercial and institutional buildings.

The Refrigeration Action Program for Buildings (RAPB) was launched in 2003 under the *Climate Change Plan for Canada* and focuses on the deployment of innovative refrigeration technologies integrated with a building's HVAC systems, in order to drastically reduce refrigerant losses, allow the recovery and upgrade of the heat rejected by the refrigeration system, and adapt the system's operation to the Canadian climate. To meet its objective, the RAPB performs capacity building, demonstration, information and training activities in partnership with key stakeholders, for Canadian supermarkets, ice rinks and curling rinks. The RAPB also undertakes research and development activities on refrigeration technological solutions.

Key 2003–2004 Achievements

- Start-up of a demonstration project of integrated HVAC and refrigeration technologies in the Loblaws supermarket in Repentigny, Quebec, as well as in three ice rinks. In addition, technical fact sheets and feasibility study analysis tool software have been produced.
- The Val-des-Monts ice rink demonstration project received the 2003 Jury's Award at the Energia Competition in Quebec, and was finalist for a Phoenix prize in an environmental competition.
- The CETC–Varennes refrigeration team was the successful bidder and won a research project contract from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the world's most referenced organization related to all aspects of HVAC and refrigeration systems and equipment, to improve Chapter 34 of the 2002 *ASHRAE Refrigeration Handbook* content on the design of ice rink refrigeration systems.

For more information:
cetc-varennes.nrcan.gc.ca/en/ref.html

Equipment: **Buildings Program – Intelligent Buildings**

Objective: To develop and promote the adoption of intelligent building technologies and innovative building operation practices that reduce energy consumption and GHG emissions.

The program focuses on intelligent building technologies and practices, such as re-commissioning, that reduce a building's energy consumption while ensuring the occupants' comfort and preserving indoor air quality. To meet its objectives, the program develops, demonstrates and deploys, in partnership with key stakeholders, intelligent buildings technologies in Canadian commercial/institutional buildings.

Key 2003–2004 Achievements

- Developed a business case for the use of intelligent building technologies to improve building operation in Canada. The business case demonstrated that building operation optimization can have significant benefits in terms of energy efficiency, GHG emission reductions and improvement of indoor air quality for buildings. DABO, the Diagnostic Agent for Building Operators, developed by CETC–Varennes, is a key element in the persistence of the benefits.
- A new version of DABO with added diagnostic capabilities has been developed and installed at the Montréal – Pierre Elliott Trudeau International Airport in Dorval, Quebec; the Federal Training Centre in Laval, Quebec; and the Arena of Amqui, Quebec; as well as at the headquarters of Delta Controls Inc. in Surrey, British Columbia.

For more information:
cetc-varennes.nrcan.gc.ca/en/b_b/bi_ib.html

Equipment: **Building Energy – Simulation Program**

Objective: To contribute to the improvement of design, performance, cost-effectiveness, integration and deployment of energy-efficient building technologies and techniques, through simulation modelling and applications-driven implementation tools for the market.

Through this program, the Simulation Team develops, distributes and supports building simulation software for the Canadian housing and building industry. These software tools are used by architects and engineers to optimize the energy performance of individual technologies and whole building designs, as well as to demonstrate compliance with such programs as the R-2000 Standard, EnerGuide for Houses and (New) Houses, CBIP, the *Model National Energy Code for Buildings* and the *Model National Energy Code for Houses*. The team is involved in all aspects of the software development process, from design and programming to distribution, maintenance, and user training and support.

The Simulation Team developed the next generation residential energy analysis software, HOT3000™, a more advanced version of HOT2000™, with a more comprehensive and expandable simulation engine (based on the ESP-r program). HOT3000 is capable of expanding to meet the complexities of the energy-saving technologies and strategies entering the market and emerging in industry research and development. The ESP-r program was created by the University of Strathclyde in Scotland and modified by CETC to meet Canadian simulation needs. The University of Strathclyde remains a collaborator on several simulation software development projects.

Key 2003–2004 Achievements

- Became first in the world to have a fuel cell model integrated into a whole-building simulation program. This model is an important tool for analysing and studying distributed generation systems for buildings.
- Established and chairs a research annex on the modelling of residential cogeneration systems under the International Energy Agency, taking a lead role internationally in the development and validation of methods for modelling fuel cell and other cogeneration systems.
- Using CETC software, over 128 000 houses and 380 commercial buildings have been simulated for improved energy efficiency to date.
- Delivered full-day training courses on the ESP-r/HOT3000 simulation engine to graduate students sponsored by the University Research Network, as well as to university professors and simulation software users.
- Further developed Web-based "wizards" to perform accurate building analysis.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

HOT2000 is an official mark of Natural Resources Canada.

HOT3000 is a Trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

Community Energy Systems: **Community Energy Systems Program**

Objective: To increase the sustainability of Canadian communities by addressing their energy needs.

This program works in partnership with Canadian communities and businesses to address energy needs through a holistic approach to energy efficiency, renewable energy and community energy planning. NRCan has supported many district energy projects (some of which are based on renewable energy such as using waste energy from the local power plants) in Ontario, Prince Edward Island, the Northwest Territories, Nunavut and Yukon. NRCan continues to help communities to develop Sustainable Community Energy Plans, using tools that are designed to reduce energy demand, emphasize conservation and promote reliance on local renewable energy sources.

Key 2003–2004 Achievements

- Continued the community energy training program and held workshops in Springhill and Port Hawkesbury, Nova Scotia, and in Pembroke, Ontario.
- Developed a planning methodology that enables municipalities to develop a long-term growth strategy while minimizing energy consumption and maximizing renewable energy.
- Sponsored the Canadian District Energy Association Conference and the Federation of Canadian Municipalities' study tour to Europe.
- Supported a field trial of a high-efficiency, 60-kilowatt microturbine installation supplying heat and power to Place des Arts, Montréal. This project was also funded by Hydro-Québec and Gaz Métro, and the packaged heat recovery turbine system was supplied by Mariah Energy Corporation of Calgary.
- Carried out a study of the properties of a Drag Reducing Agent that is capable of reducing by approximately 80 percent pumping costs in buildings or district heating systems. Constructed a test rig to mimic a district heating system in tests of building energy transfer stations.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_ces_e.html

Chapter 6: Industry

Energy Use and Greenhouse Gas Emissions

The industrial sector includes all manufacturing industries, all mining activities, forestry and construction; however, it excludes electricity generation. This sector uses energy in industrial processes as a source of motive power to produce heat or to generate steam. Overall, industrial energy demand accounts for 38.7 percent (3176 petajoules) of secondary energy use and 33.8 percent (163 megatonnes) of greenhouse gas (GHG) emissions (including electricity-related emissions).

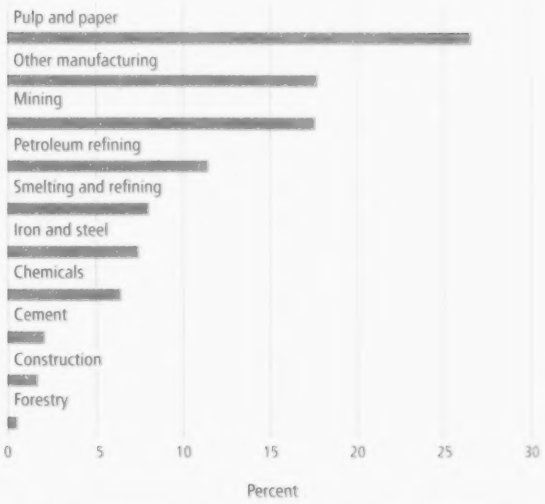
Within the industrial sector, energy is consumed primarily in pulp and paper, mining, petroleum refining, and smelting and refining industries. Pulp and paper alone accounted for almost 27 percent of total industrial energy demand in 2002 (see Figure 6-1).

In most industries, energy purchases account for only a small proportion of total expenditures. However, for some relatively energy-intensive industries – cement, chemicals, and pulp and paper – this share is higher than 14 percent (see Figure 6-2). For cement, in particular, the share is as high as 39 percent.

Actual industrial energy use increased by 16.9 percent (459 petajoules) between 1990 and 2002. This increase was driven by a 43.5 percent increase in industrial activity, measured as a combination of physical units of production, gross output and gross domestic product (GDP). However, some of this increase in energy use that would have resulted from the increase in activity was offset by improvements in energy efficiency and structural change – the shift to less energy-intensive industries (such as electrical and electronics).

FIGURE 6-1

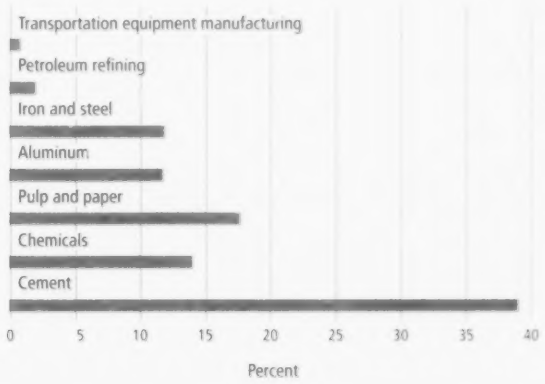
Industrial Energy Use by Sub-sector*, 2002



* Note: The above sub-sectors reflect the current definitions in the *Report on Energy Supply-Demand in Canada*. "Other manufacturing" comprises more than 20 manufacturing industries.

FIGURE 6-2

Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2002



Three main factors influenced energy use:

- activity – increases in physical units of production, gross output and GDP contributed to a 43.5 percent increase in industrial activity resulting in a 1183-petajoule increase in energy use
- structure – the change in the mix of activity toward less energy-intensive industries resulted in a 338-petajoule decrease in energy use
- energy efficiency – due to a 14.2 percent improvement in energy efficiency (between 1990 and 2002), the industrial sector avoided 386 petajoules of energy use in 2002 alone

The change in energy use between 1990 and 2002 and the estimated energy savings due to energy efficiency are shown in Figure 6-3.

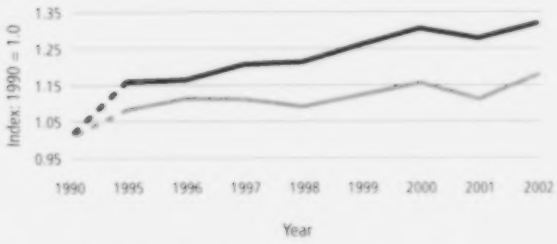
Between 1990 and 2002, industrial GHG emissions including electricity-related emissions increased by 15.2 percent. Excluding electricity-related emissions, industrial GHG emissions increased by only 8.2 percent over the same period. Most of this increase occurred in the upstream mining industry, while mining (excluding upstream), manufacturing and construction industries realized a 3.4 percent decrease in GHG emissions.

Natural Resources Canada (NRCan) delivers initiatives to increase energy efficiency in the following components of the industrial sector:

- industrial processes and technologies
- equipment
- buildings (refer to Chapter 5)

Figure 6-3

Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002



Industrial Processes and Technologies: **Industrial Energy Efficiency**

(Canadian Industry Program for Energy Conservation [CIPEC] and Industrial Energy Innovators [IEI])

Objective: To help Canadian industry use energy efficiency investments to improve competitiveness and to contribute to Canada's climate change goals.

CIPEC is a unique industry-government partnership committed to promoting and encouraging energy efficiency improvements and reductions in GHG emissions through voluntary action across Canada's industrial sectors. CIPEC comprises 25 sector task forces that involve more than 45 trade associations.

CIPEC, a sector-level program, and IEI, a company-level program, both address barriers to planning, implementing, tracking and reporting energy efficiency projects in industry. Key elements include the establishment and tracking of energy efficiency improvement targets and plans, and the development of products and services that overcome barriers to continued energy efficiency improvements. NRCan provides support via employee awareness kits and events, best-practices guides, technical information, energy audits, benchmarking and workshops on energy management.

CIPEC targets all of industry, including mining, manufacturing and construction as well as upstream oil and gas and electricity generation. Between 1990 and 2002, CIPEC mining, manufacturing and construction industries achieved an average energy-intensity improvement of 1.9 percent per year, thereby avoiding 23.8 megatonnes in GHG emissions. During this same time period, all CIPEC industries (including oil and gas and electricity generation) achieved an average energy-intensity improvement of 0.7 percent per year, thereby avoiding 25.2 megatonnes of GHG emissions. Effective energy management by CIPEC companies resulted in $3.4 billion in savings in 2002. As Figure 6-4 demonstrates, significant energy intensity improvements occurred in the latter part of the last decade. Between 1996 and 2002, energy intensity decreased by 11.0 percent.

FIGURE 6-4

CIPEC Energy Intensity Index, 1990–2002

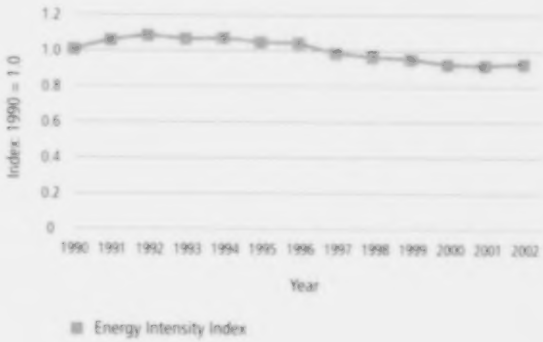
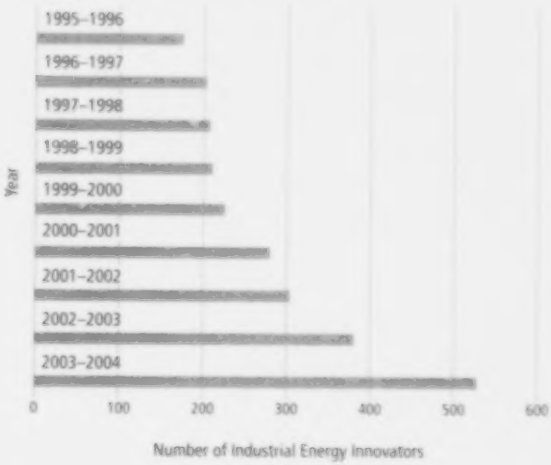


FIGURE 6-5

Industrial Energy Innovators, 1995–1996 to 2003–2004



According to a recent study, there is a statistically significant difference between energy consumed by CIPEC participants and non-participants:

- Growth of energy consumption for CIPEC participants was approximately half of that of non-participants (2.2 percent growth versus 5.4 percent growth).
- Three times more participants reported reduced energy use than non-participants.
- Fifteen percent fewer participants reported an increase in energy use than non-participants.

Key 2003–2004 Achievements

- Recruited 147 new Industrial Energy Innovators (see Figure 6-5).
- Initiated 152 Industrial Energy Audits.
- A study completed in May 2003 found that industrial companies that have participated in Dollars to $ense workshops have together saved more than 3 petajoules of energy and 184 kilotonnes of carbon dioixde (CO_2) equivalent per year.

For more information:
oee.nrcan.gc.ca/cipec/ieep

Industrial Processes and Technologies: **Cleaner Fossil Fuel Power Generation**

Objective: To design, develop and deploy technologies for power generation from fossil fuels with increased efficiency, and reduction and ultimately elimination of emissions of acid rain precursors, GHGs, particulates and identified priority substances – mercury, trace elements and organic compounds.

Research focuses on improving performance and reducing emissions for existing fossil fuel power plants and on developing new advanced cycles for conversion of fossil fuels to electricity with complete or near complete capture and elimination of CO_2 and other emissions. Additional research undertaken includes issues associated with the transport and storage of CO_2.

Key 2003–2004 Achievements

- Developed Canadian technology roadmaps that identify technologies that will be needed for the clean and efficient use of coal with CO_2 capture and storage – to be published in 2005.
- The Canadian Clean Power Coalition completed its evaluation of clean coal technology options for new power plant construction and is proceeding with plans to build a new clean coal technology power plant meeting near zero emissions into the atmosphere by 2010.
- Commissioned a new pressurized gasifier pilot plant capable of operating at 1400°C. The unit, the only one of its type in North America, will act as an economical testbed for Canadian utilities interested in advanced technology development, hydrogen production and CO_2 capture. Gasification provides high electricity generation efficiency; allows CO_2 capture at low cost and low energy penalty; permits economical, highly efficient removal of sulphur oxide, nitrogen oxide and mercury; and will provide energy security through clean use of Canada's indigenous coal reserves.
- Designed, manufactured, tested and patented a 100-megawatt equivalent oxy-fired gas turbine. The technology enables CO_2 and mercury capture through O_2/CO_2 combustion.
- Implemented with Canadian International Development Agency (CIDA), Canada Climate Change Development Fund, the Chinese government and private sector partners, a $3.1-million research and technology transfer project for power generation in China that will result in GHG reductions of up to 3.5 million tonnes over 10 years.
- Devised a new combustion protocol for assessing energy and emission performance of bitumen/water emulsions for industrial applications. This emulsified fuel can replace natural gas in the steam-assisted gravity drainage recovery of oil sand bitumen.
- Developed and tested, in cooperation with Ontario Power Generation, a low-cost sorbent injection, mercury capture technology for coal-fired electric utility boilers.
- Successfully demonstrated a new measurement and characterization methodology for $PM_{2.5}$ fine particulate matter emissions. Application of Canada-wide standards to large industrial sources in 2010 will require reliable measurement methods.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_e.html

Industrial Processes and Technologies: **Processing and Environmental Catalysis Program**

Objective: To solve industrial process problems and undertake research in areas with high potential for significant environmental and economic benefits

The program's facilities, including semi-pilot scale plants, are used for process testing and the evaluation of novel concepts in chemical and energy conversion, including hydrogen production from hydrocarbon and renewable sources. Clients include oil and gas companies, petrochemical companies, original engine manufacturers, waste oil renderers and specialty ceramic manufacturers.

Key 2003–2004 Achievements

- Developed a process for stabilizing/conditioning a diesel fuel derived from waste motor oil. CANMET Energy and Technology Centre (CETC) received its first royalty payment from licensing the process to a Malaysian company. A commercial plant was commissioned in December 2004.
- Developed ceramic membranes for hydrogen separation at high temperatures. This is an enabling technology to improve energy efficiency and economics of hydrogen production and hydrogen recovery in the petroleum/petrochemical industries. Reproducibility of membranes is now approaching 100 percent.
- Developed zero emissions ammonia fuel cells in collaboration with CANMET Materials Technology Laboratory. Proof of concept has been demonstrated, resulting in two peer-reviewed journal publications. Preliminary assessment indicates a significant market opportunity exists for 10–20 kilowatt fuel cells in distributed power generation. Two ammonia producers have expressed interest in this technology.
- Developed a technology for the production of low-sulphur, high-cetane blending stock from waste restaurant grease and vegetable oils. Life-cycle analysis shows a 23 percent reduction in GHG emissions using a 20 percent blend of tallow-derived SuperCetane and diesel fuel. A 20-litre production run was done for the Government of Ontario using soy oil as a feedstock.
- Developed a highly energy-efficient process for converting naphtha to olefins. Catalyst testing was done for Valeo Management Services, a technology development company spun off from Concordia University.
- Developed pyroelectric generation technology. This technology produces electricity from low-grade waste heat for increased industrial plant efficiency, and it avoids GHG emissions due to combustion of fossil fuels to provide part of or all of the power requirements of an industrial plant. The power density of lab-scale prototype units has reached 300 watts per litre of active material.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_pec_e.html

Industrial Processes and Technologies: **Industrial System Optimization Program**

Objective: To support the development and adoption of innovative energy-efficient practices in Canadian industry to continuously improve its energy efficiency and productivity, while decreasing GHG emissions and other environmental impacts.

The program focuses on systematic industrial process analysis methods and techniques, such as Process Integration (PI) and advanced process control systems, to identify and correct inefficiencies in plant operation taking into account energy, economy and environmental aspects. It seeks to meet its objective by performing leveraged research and development through national and international collaboration. Furthermore, the program disseminates technical information that will encourage the adoption of these practices in targeted energy-intensive sectors of Canadian industry including pulp and paper, oil upgrading and refining, petrochemicals, steel, chemicals, solid wood, and food and drink.

Key 2003–2004 Achievements

- Completed a successful collaboration in PI with Cascades Inc., a North American leader in the production, conversion and marketing of packaging products; this collaboration entailed training engineers and the completion of two PI studies. This initiative allowed Cascades to identify cost-effective energy savings of $4.5 million per year, with an average payback period of eight months, and GHG emission reductions of 34 kilotonnes per year.
- Disseminated information on the value of PI by participating in a series of six technical workshops with representatives of energy-intensive Canadian industries, and through a unique and high quality Web site.
- Conducted a survey on energy performance of sawmills in the province of Quebec that showed that there is room for significant energy savings. Furthermore, decision-making tools were developed for better process operation and energy management in sawmills using a data mining approach.

For more information:
cetc-varennes.nrcan.gc.ca/en/indus.html

Industrial Processes and Technologies: **Industry Energy Research and Development (IERD) Program**

Objective: To encourage and support the development and application of leading-edge, energy-efficient and environmentally responsible processes, products, systems and equipment in industry.

Financial support is provided for commercially confidential applied research and development (R&D) activities, which is repayable if the project is commercially successful. Program clients from all industrial sectors range from small- and medium-sized companies to multinational corporations.

Key 2003–2004 Achievements

- Further to the successful completion of an IERD-supported R&D project, Turbocor Inc. of Montréal, Quebec, is commercializing a novel compressor for refrigeration applications that requires no lubricating oils and has no chlorofluorocarbons. This represents a breakthrough in industrial and commercial refrigeration and is generating energy savings of 30 percent. Turbocor won a Canada's Energy Efficiency Award in early 2003, the 2003 Air-Conditioning, Heating and Refrigeration Expo's "Energy Innovation" Award and most recently the 2004 U.S. *Environmental Protection Act* Climate Protection Award, which is given to organizations for the extraordinary accomplishments that have made significant contributions to protecting the environment.
- Société des technologies de l'aluminium du Saguenay in Chicoutimi, Quebec, is working at developing, in partnership with Lauralco Inc. in Deschambault, Quebec, an automated anode replacement and positioning system. This system will increase energy efficiency of the aluminum smelting process and reduce GHG emissions. This system is forecast to be in service by end of 2004.
- Systèmes d'Optimisation Énergétiques Inc., Saint-Mathieu-de-Beloeil, Quebec, is a young company that is developing a new mechanical transmission for diesel generator sets. The projected energy savings is in the 15 to 25 percent range. This new device will also permit extension of the diesel engine life by 25 percent.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/factsheet_industry_energy_research_and_development_program_e.html

Industrial Processes and Technologies: **Emerging Technologies Program (ETP)**

Objective: To support the identification and demonstration of new and emerging energy-efficient technologies.

Projects are co-managed and cost-shared with industry and other stakeholders, such as gas and electric utilities, other governments and equipment manufacturers. Financial support is provided for the development and testing of pilot plants, prototypes and full-scale field trials to evaluate operating performance, energy efficiency and environmental impacts. NRCan's financial support is repayable from any cost savings or revenues realized from a project.

Key 2003–2004 Achievements

- NRCan is supporting Sirex Engineering of Mississauga, Ontario, in its development of a production-scale process that recycles post-industrial polyethylene cross-linked foam waste material into foam sheet products. Pressure on landfill sites will be alleviated and substantial energy reduction will be achieved by supplanting or replacing a new stream of polyethylene foam and the depletion of petrochemical feedstocks.
- Westport Research Inc. of Vancouver, British Columbia, with NRCan support, has delivered and installed a natural gas engine for stationary power generation to a water/wastewater treatment facility in Grande Prairie, Alberta, and by September 2004 will complete a one-year field trial of a low-emissions (17.8 percent less CO_2) natural gas engine for stationary power generation using the Westport high-pressure direct injection technology.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/funding_programs_etp_e.html

Industrial Processes and Technologies: **Industrial Energy Innovation**

Objective: To assist major industrial energy consumers to reduce the energy intensity of their operations and to reduce GHG emissions, by-product emissions of CO_2 and other GHGs.

Industrial combustion processes are the major sources of industrial GHG emissions. Because they operate at low thermal efficiencies of 30 to 50 percent, there are major opportunities to improve industrial energy efficiency and productivity while significantly reducing GHG emissions.

CETC's work in this area includes changing the interaction of the combustion system with the process, with advanced tools and technologies. As well, together with the Large Final Emitters Group and the Office of Energy Efficiency, CETC held technical workshops with major industry sectors (steel, mining, smelting and refining, cement, lime, and pulp and paper) and with CIPEC, industrial associations and individual companies to help define and map partnerships for a generic industrial combustion R&D program and applications to take advantage of these opportunities, with potential energy and GHG reductions of 10 to 40 percent. In addition, it is engaged in developing generic tools and technologies that cross industry sectors, fuels and furnaces.

Key 2003–2004 Achievements

Numerous projects contributed the following:

- greater energy efficiency in the making of iron and steel
- higher energy efficiency and reduced GHG emissions in coking processes used in the iron and steel industry
- development of high-efficiency, low-nitrogen-oxide burners for industry
- application of low-cost computational fluid dynamic (CFD) modelling as a pre-cursor to large engineering projects to inject natural gas into blast furnaces and upgrade a refinery heater
- improved performance and reduced emissions in flaring emissions in refining and chemical industries through flare tip redesign and a software tool to assess oil field emissions
- test facility for combustion performance of bio-oil in micro-turbine and other combustors
- developed scanner technology that monitors burner performance and optimizes operation for industrial applications

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_e.html

Industrial Processes and Technologies: **Minerals and Metals Program**

Objective: To reduce GHG emissions from Canada's Minerals and Metals Sector by enhancing mineral and metal recycling processes and practices, and by assessing alternate production processes. The initiative has a GHG reduction target of at least 1.65 million tonnes of CO_2 equivalent per year, by 2010.

The Minerals and Metals Program is a component of the *Government of Canada Action Plan 2000 on Climate Change*. The Minerals and Metals Program was restructured in 2003–2004 to allocate $10 million to two distinct areas: Enhanced Emission Reduction for Minerals and Metals, and Enhanced Recycling. The Program is managed by a Steering Committee consisting of representatives from Environment Canada, Industry Canada and Natural Resources Canada (Chair) and two program-area-specific Advisory Committees, consisting of experts in the field and representatives from industry, government and non-governmental organizations. Daily operations are overseen by the CANMET Mineral Technology Branch. The Enhanced Emission Reduction for Minerals and Metals program area supports activities that will increase the use of fly ash, blast-furnace slag, silica fume and other Supplementary Cementing Materials (SCMs) in concrete to displace Portland cement, thereby reducing the GHG intensity of concrete production. The Enhanced Recycling program area aims to increase Canada's potential to recycle all materials by developing new approaches and improving upon existing recycling infrastructure, practices and policies.

Key 2003–2004 Achievements

- EcoSmart™ Foundation Inc. received funding for several technical studies and a national expansion to broaden the impact of its work.
- CANMET's Materials Technology Laboratory began development of a user-friendly tool for contractors wanting to use SCMs in their construction projects. The program also supports a broad range of initiatives such as examining cogeneration and CO_2 sequestration.
- The Enhanced Recycling program raised awareness of many important issues among a broad group of stakeholders across Canada, especially at the municipal and regional level, through participation in various communications opportunities. Other activities included completion of a scan of metals and minerals recycling programs to determine effectiveness and ongoing improvements in statistics/data collection for secondary resources in order to identify gaps in current recovery strategies.

For more information:
nrcan.gc.ca/mms/canmet-mtb/mtl/research/concrete_e.htm

Equipment: **Energy Efficiency Standards and Regulations**

Objective: To eliminate the less energy-efficient models of energy-using equipment from the market through minimum performance regulations under the *Energy Efficiency Act*.

The *Energy Efficiency Regulations* incorporate national consensus performance standards that include testing procedures to determine the energy performance of the equipment. They prohibit the import of, or interprovincial trade in, prescribed products that fail to meet minimum energy performance levels and labelling requirements.

Key 2003–2004 Achievements

- Pre-published eighth amendment to the *Energy Efficiency Regulations* to increase the minimum energy-performance standards for clothes washers and gas-fired and electric storage water heaters, and to establish minimum energy-performance standards for water chillers and exit signs.
- The cumulative annual reductions in CO_2 emissions resulting from the aggregate energy savings attributable to the eighth amendment to the *Energy Efficiency Regulations* are estimated to be approximately 0.19 megatonnes in the year 2005 and 3.61 megatonnes in the year 2020.

For more information:
oee.nrcan.gc.ca/regulations/home_page.cfm

Equipment: **Labelling and Promotion**

Objective: To promote the production, purchase and use of more energy-efficient equipment.

The initiative consists of EnerGuide for Equipment, which provides comparative information on the energy performance of equipment – including heating, ventilating and air conditioning (HVAC) – and the ENERGY STAR® label, which allows industrial purchasers to identify the most energy-efficient products available based on a standard set of criteria.

Key 2003–2004 Achievements

- Market studies completed for compressors, uninterruptible power supplies, battery chargers, arc welding and pumps.

For more information:
energuide.nrcan.gc.ca
oee.nrcan.gc.ca/equipment
energystar.gc.ca

Equipment: **Mine Ventilation**

Objective: To reduce energy consumption and GHG emissions associated with mine ventilation through infrastructure automation (to support demand-based delivery systems), ventilation network optimization and management, and less air-volume demanding technology.

Mine ventilation systems that were traditionally designed to operate at maximum flow (peak production 24 hours a day and 7 days a week) are being adjusted to match actual production needs. Ventilation is required in underground mines to maintain a safe working environment by diluting and removing harmful pollutants (dusts and gases) and providing a thermally suitable working climate. Providing sufficient and suitable ventilation can account for 40 percent of the energy consumed underground by a mining operation. Efficient energy savings at less than peak demands range from linear for the heating/cooling systems to a cubic relationship for the primary fan system. However, optimizing energy use is not straightforward, as it depends on the specific consumption profile for each mine and therefore needs evaluation on a case-by-case basis.

Key 2003–2004 Achievements

- A "ventilation on demand" feasibility study continued for a deep-ore zone with INCO Limited's Creighton Mine. The focus was to reduce the energy demands of the existing ventilation system, delay any need for mechanical refrigeration and identify, track or control the production requirements to achieve these savings.
- A ventilation benefit analysis was completed on the potential impact of converting from diesel to fuel-cell powered production equipment. This study showed that ventilation could be reduced but other contaminants became the limiting design criteria, and the reductions in energy, GHG emissions and cost were very dependent on factors such as the mine's energy consumption profile.
- There was a collaborative development (funded by the Office of Energy Efficiency) of a mine life-cycle ventilation demand simulator. This initial simulator, which is part of an NRCan engineer's ongoing doctoral thesis, will determine where the optimal energy environment and cost benefits in mine ventilation networks exist.

For more information:
nrcan.gc.ca/mms/canmet-mtb/mmsl-lmsm/mines/air/air-e.htm

Chapter 7: Transportation

Energy Use and Greenhouse Gas Emissions

The transportation sector consists of three sub-sectors: passenger, freight and off-road. Passenger and freight transportation accounted for 56.7 percent and 39.3 percent, respectively, of transportation energy use, with off-road representing only 4.0 percent in 2002. The passenger sub-sector is composed of three modes: road, rail and air. The freight sub-sector, as defined by Natural Resources Canada (NRCan), is composed of road, rail, air and marine. Road transport uses the most energy, accounting for 78.1 percent of total transportation energy use in 2002. Of this amount, 60.5 percent was passenger energy use and 39.5 percent was freight energy use (see Figure 7-1).

All NRCan transportation energy-use programs focus on the energy used in road transportation. Total transportation energy use increased by 22.8 percent (428 petajoules) over 1990 to 2002 (see Figure 7-2). Passenger transportation energy use increased by 13.0 percent (150 petajoules), while freight transportation energy use increased by 36.0 percent (240 petajoules).

Three main factors influenced energy use:

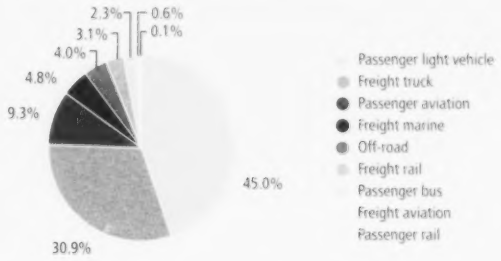
- activity – due to increases in population and economic activity, there was greater transportation activity (measured as passenger-kilometres for passenger transportation and tonne-kilometres [tkm] for freight transportation). This increased transportation energy use by 23.1 percent (412 petajoules). The freight and passenger segments contributed to this increase by 57.7 percent and 42.3 percent, respectively.
- structure – shifts between modes of transport were significant in passenger (sharp increase in the stock of light trucks) and freight (freight trucks are growing significantly faster than rail and marine) segments, resulting in an increase of 9.3 percent in transportation energy use (165 petajoules).
- energy efficiency – improvements in energy efficiency worked to decrease energy use by 9.9 percent (178 petajoules).

Without improvements in energy efficiency, increases attributable to activity and structure would have led to an increase in transportation energy use of 32.4 percent (577 petajoules). However, as a result of improvements in energy efficiency, actual energy use increased by 22.8 percent. This change in energy use between 1990 and 2002, as well as the estimated energy savings due to energy efficiency, is shown in Figure 7-2.

The transportation sector accounts for 28.1 percent (2306 petajoules) of secondary energy use and 34.2 percent (165 megatonnes) of greenhouse gas (GHG) emissions. From 1990 to 2002, transportation energy use increased by 22.8 percent, and GHG emissions increased by 22.1 percent. The change in GHG intensity of transportation energy use was negligible.

FIGURE 7-1

Transportation Energy Use by Mode, 2002



* Totals do not add due to rounding

Figure 7-2

Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

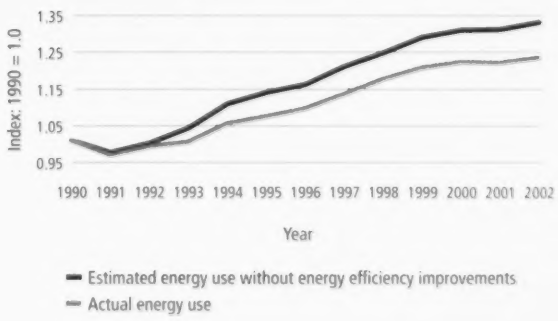


FIGURE 7-3

Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2002

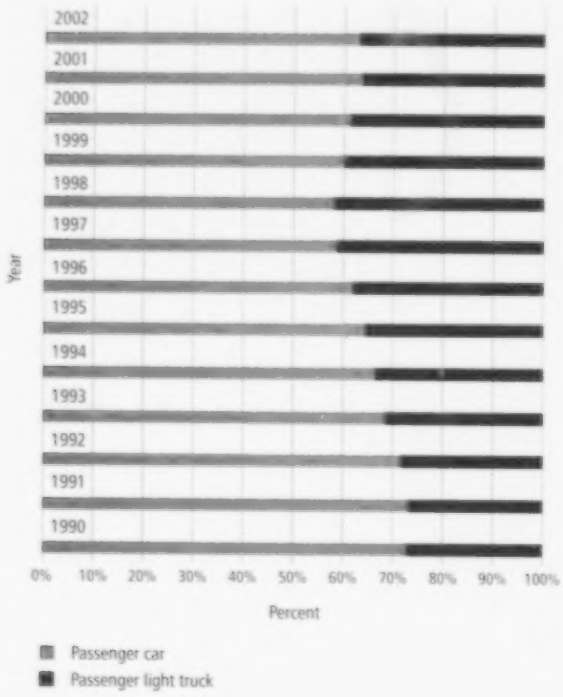


Figure 7-3 shows how the market share of new light trucks increased in the 1990s, reflecting the growth in popularity of minivans and sport-utility vehicles. Figure 7-4 demonstrates that, on a per-kilogram or per-unit-of-horsepower basis, fuel efficiency has improved markedly. However, average fuel economy has been stable because new vehicles continue to be heavier and have more powerful engines.

Figure 7-5 illustrates an improvement in trucking energy intensity despite an increase in average activity over 1990 to 2002. Improved fleet practices, caused by an increase in the competitiveness of the transportation sector and by the introduction of electronic engines, have significantly improved engine fuel efficiency in medium-duty and heavy-duty trucks.

NRCan delivers initiatives in the following areas to increase the efficiency of motor vehicles and encourage the use of alternative fuels:

- vehicles
- transportation research and development
- alternative transportation fuels
- transportation technologies

Figure 7-4

New Car Fuel Efficiency, Normalized for Weight and Power, 1990 to 2001

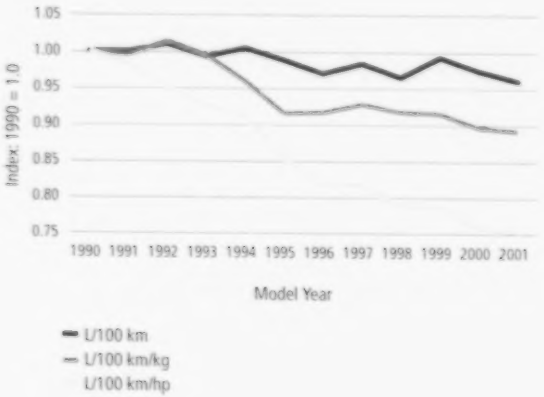
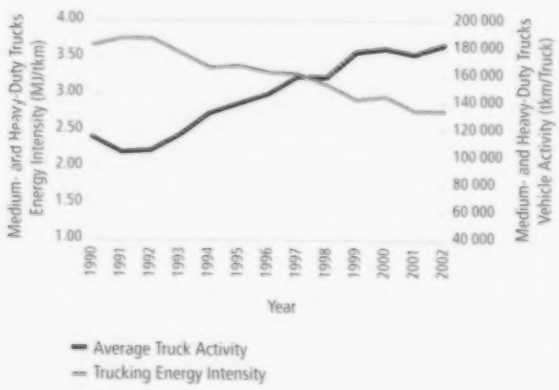


Figure 7-5

Changes in Trucking Energy Intensity and Average Activity per Truck, 1990–2002



Vehicles: **Vehicle Efficiency**

Objective: To improve the fuel efficiency of new light-duty vehicles sold in Canada.

The Motor Vehicle Fuel Efficiency Initiative is intended to bring about a 25 percent improvement in the fuel efficiency of new light-duty vehicles sold in Canada by 2010. NRCan is leading negotiations with the automotive industry to reach agreement on a voluntary fuel efficiency target for new vehicles. GHG reductions of 5.2 megatonnes in 2010 are being sought.

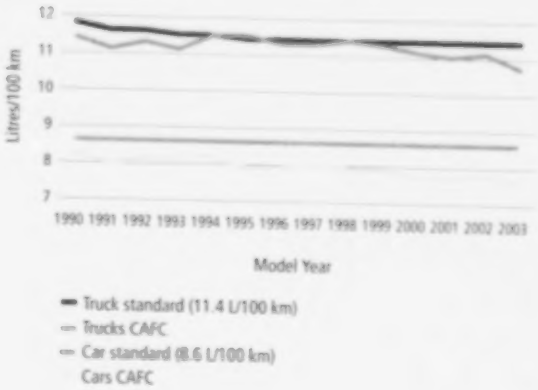
Key 2003–2004 Achievements

- Completed a joint study between NRCan and U.S. Department of Energy on the future potential of hybrid and diesel powertrains in the North American light-duty vehicle market.
- Completed round of discussions with auto industry regarding fuel efficiency targets.

For more information:
oee.nrcan.gc.ca/english/programs/motorvehicles.cfm

Figure 7-6

Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2003



Vehicles: Personal Vehicles

Objective: To improve motor vehicle fuel efficiency by encouraging private motorists to develop energy-efficient vehicle purchase, use and maintenance practices.

The Personal Vehicle information program promotes improving vehicle fuel efficiency in order to reduce vehicle emissions and mitigate other vehicle-related environmental impacts. The program helps motorists understand how automobile purchases and driving and maintenance habits affect climate change and the environment. It encourages Canadians to purchase the most fuel-efficient vehicle that meets their everyday needs and to adopt fuel-efficient driving techniques and maintenance practices.

Key components include the EnerGuide fuel-consumption label for vehicles and the annual *Fuel Consumption Guide*, which provide fuel consumption data for new light-duty vehicles; the Idle-Free Campaign, which seeks to curb vehicle idling; and the Auto$mart Driver Education Kit, which helps driving instructors teach fuel-efficient driving to novice drivers. Recently the initiative developed a national public awareness and education campaign, in collaboration with the tire manufacturing industry, to encourage Canadian motorists to adopt good tire maintenance and inflation practices.

Key 2003–2004 Achievements

- Successfully completed the Idle-Free Campaign in Calgary, Edmonton, the Greater Toronto Area, Caledon, Ottawa, Sherbrooke and Québec City.
- Tire inflation campaign developed and launched.
- Recruited one new manufacturer for the EnerGuide label for vehicles.

For more information:
oee.nrcan.gc.ca/vehicles

FIGURE 7-7

Vehicle Fuel Efficiency Awareness – EnerGuide Labels

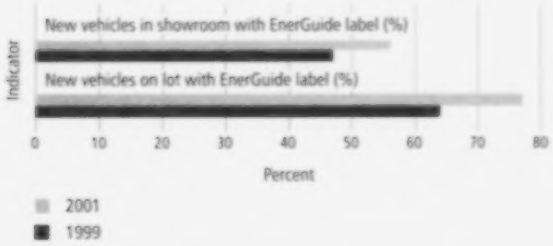


FIGURE 7-8

Vehicle Fuel Efficiency Awareness – Auto$mart

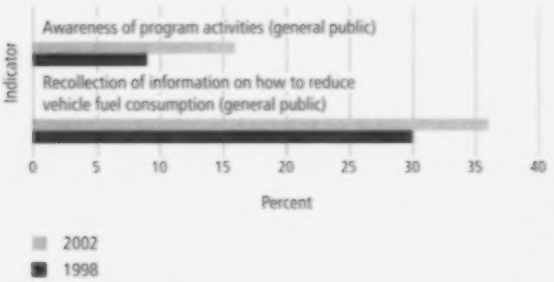


FIGURE 7-9

Number of New Drivers Educated Using the Auto$mart Student Driving Kit, 1997–1998 to 2003–2004

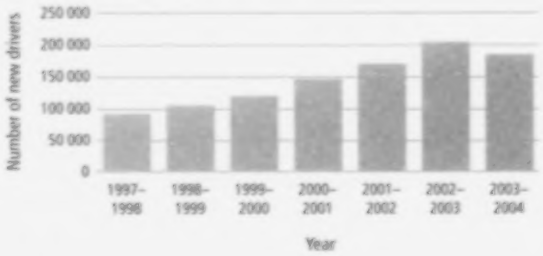
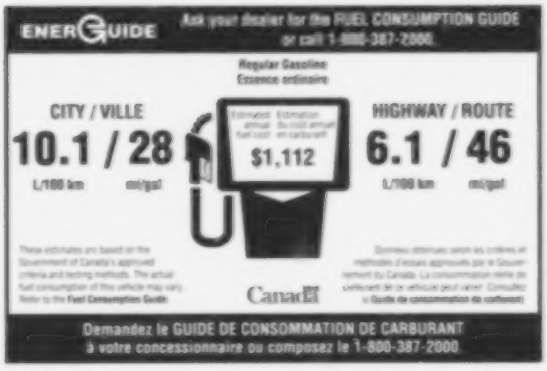


FIGURE 7-10

EnerGuide Label for New Vehicles



Vehicles: Fleet Vehicles

Objective: To improve motor vehicle fuel efficiency by encouraging private motorists to develop energy-efficient vehicle purchase, use and maintenance practices.

Fleet Vehicles provides information materials, workshops, technical demonstrations, driver training programs and special projects, such as the Truck Stop Idle-Free Quiet Zone Campaign, to help fleet operators assess and pursue opportunities to increase energy efficiency in their operations. To increase market penetration of fuel-efficient and emission-reduction technologies, the Fleet Vehicles initiative also provides financial incentives to commercial fleets purchasing pre-selected anti-idling technologies and Natural Gas Vehicle technologies. NRCan delivers the Fleet Vehicles initiative in partnership with fleets, industry stakeholders and other levels of government.

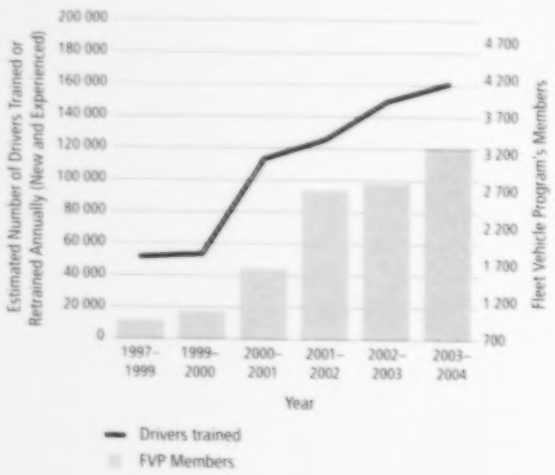
Key 2003–2004 Achievements

- The SmartDriver workshops trained more than 160 000 new and experienced drivers and introduced over 700 new instructors to the SmartDriver materials.
- Three anti-idling technologies have been certified under the Commercial Transportation Energy Efficiency Rebate (CTEER) initiative.
- Provided over $850,000 in incentives through the CTEER initiative

For more information:
fleetsmart.nrcan.gc.ca

FIGURE 7-11

Drivers Trained and Participation in the Fleet Vehicle Program, 1997 to 2004



Transportation Research and Development: **Canadian Lightweight Materials Research Initiative (CliMRI)**

Objective: To develop low-density, high-strength, lightweight materials to achieve weight reductions in ground transportation vehicles.

CLiMRI is a research network comprising twenty-nine companies, eight universities and seven government departments and funding agencies. CLiMRI's goal is to develop and implement lightweight and high-strength materials in transportation applications for the purposes of (a) reducing GHG emissions through vehicle weight reduction and improving vehicle efficiency, and (b) improving the competitive performance of Canadian primary metals producers, automotive part manufacturers and suppliers.

Key 2003–2004 Achievements

- Magnesium is one of the lightest of all metals, but its use in automotive applications is currently limited to die-cast parts because of difficulties in producing magnesium in sheet form. CANMET Materials Technology Laboratory (CANMET-MTL) has developed a moving plate to simulate the twin-roll strip casting of magnesium sheets, and the material's performance is being assessed. This achievement shows significant potential for increasing the use of magnesium in the automotive industry.
- Unlike aluminum, magnesium is prone to corrosion in the presence of chlorides such as road de-icing salt. Corrosion control is therefore a key enabling technology that will lead to wider-scale application of magnesium in automobiles. As part of a large program with the U.S. Department of Energy and car makers, CANMET-MTL is leading the corrosion control and coating assessment research for magnesium alloys. Environmentally friendly coatings have been selected, and a new candidate material developed for use as spacers and washers. The team also contributed to the redesign of a magnesium engine cradle for General Motors Corporation's Corvette.
- Recent developments in hydroforming, a metal-shaping process that uses gas or water at high pressures to form tubes or sheet metal, have enabled significant productivity gains and weight reductions for complex structural components in the automotive industry. In the last year, CANMET-MTL fabricated aluminum and high-strength steel tubes and optimized welding parameters. Testing trials confirmed the validity of laboratory tests for predicting the integrity of aluminum hydro-formed seam-welded tubes.

For more information:
climri.nrcan.gc.ca/default_e.htm

Transportation Research and Development: **Fuel-Cell-Powered Mining Vehicles**

Objective: To develop the technology to replace diesel power by hydrogen fuel cell power in underground mining vehicles.

NRCan has taken a co-leadership role in the North American Consortium for Fuel-Cell-Powered Mining Vehicles. Hydrogen fuel cell power systems are twice as efficient in delivering power as conventional diesel equipment. Retrofitting diesel-powered vehicles with hydrogen fuel cells improves vehicle productivity, operating costs and the work environment for underground miners by eliminating toxic underground diesel emissions and by reducing heat and noise. Fuel cells have also been shown to have the potential to significantly reduce carbon dioxide (CO_2) or GHG emissions by up to one million tonnes per year (26 percent of the total CO_2 emitted by the mining extraction sector) and decrease operating costs by lowering mine ventilation needs by 20 to 40 percent, depending on the mine.

Key 2003–2004 Achievements

- The fuel cell locomotive is now at the experimental mine in Val-d'Or, Quebec, undergoing long-term reliability testing of the fuel cell power plant. Tests are being carried out to quantify power delivery, hydrogen consumption, risk quantification and refuelling aspects.
- Assembled partners and initiated the fuel cell underground mine loader project (the main production vehicle). The loader power plant has been designed and full vehicle testing will start in 2005.
- Initiated a light-duty mining vehicle project, representing the most polluting of underground diesel mining vehicles. It will be the focus of an all-Canadian partnership for commercialization initiative.
- Addressed mine regulatory issues in several new projects and partnership discussions to have fuel cells in operation in underground Canadian mines.
- Continued technology transfer made through a special session of the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) 2003 Annual General Meeting, two publications in the CIM Bulletin, one article in the Journal of Power Sciences, and an article in the 2003 Canadian Computer Application to the Mineral Industry Conference proceedings.

For more information:
nrcan.gc.ca/mms/canmet-mtb/mmsl-lmsm/mines/mines-e.htm

Alternative Transportation Fuels: **Future Fuels Initiative**

Objective: To increase Canada's fuel ethanol production and use in the transportation sector.

The Future Fuels Initiative, co-managed with Agriculture and Agri-Food Canada, targets end-users of gasoline, provinces and territories, and existing and potential fuel ethanol producers. The Future Fuels Initiative aims to increase the supply and use of fuel ethanol produced from biomass such as plant fibre, corn, wheat and other grains. The main components of this initiative are public education and analysis of socio-economic and GHG emission impacts. Additionally, the Future Fuels Initiative includes the National Biomass Ethanol Program, administered by Farm Credit Canada, which aims to overcome lender resistance to investing in ethanol plants due to the uncertainty of future excise tax policy.

Key 2003–2004 Achievements

- Completed an ethanol-blended gasoline awareness campaign in fall 2003 in partnership with fuel retailers in Ontario and Quebec.
- Completed a national ethanol awareness survey: results show that 85 percent of Canadians are in favour of increased ethanol-blended gasoline use in Canada (Ipsos-Reid, March 2004).
- Extended GHG emission and energy use modelling capabilities.

For more information:
www.vehiclefuels.gc.ca

Alternative Transportation Fuels: **Ethanol Expansion Program**

Objective: To expand fuel ethanol production and use in Canada.

The Ethanol Expansion Program, co-managed with Agriculture and Agri-Food Canada, targets existing and potential fuel ethanol producers. The program provides contributions to new or expanded fuel ethanol production facilities through a competitive solicitation process. Selection criteria are based on the ability to maximize ethanol production and use in Canada and the ability to reduce transportation GHG emissions. Additionally, the program is investigating the range of programs that could be used to develop a successful commercial cellulose-based ethanol industry in Canada (i.e. ethanol produced from agricultural residues or wood).

Key 2003–2004 Achievements

- Completed the proposal selection process for the first round of funding and allocated contributions to seven projects from across Canada that plan to increase domestic ethanol production by a total of 750 million litres per year.
- Engaged in extensive discussions with cellulosic ethanol industry proponents.

For more information:
www.vehiclefuels.gc.ca

Alternative Transportation Fuels: **Biodiesel Initiative**

Objective: To support increased biodiesel production and use in Canada's transportation sector.

The Biodiesel Initiative supports the Government of Canada's proposed target of 500 million litres of biodiesel production per year by 2010. The main components of this initiative are research and development, technical and socio-economic studies, end-use demonstrations and testing, stakeholder education and standards development.

Key 2003–2004 Achievements

- Commissioned long-haul commercial transport, marine and fleet vehicle end-use technology demonstration projects.
- A biofuels quality registry was established with the Alberta Research Council – a centre of excellence in this field – to set an industry protocol and standard for fuel analysis.
- Formation of an international cooperated effort to conduct a biosafety assessment on the use of animal fats in biodiesel.
- Ongoing technical and economic assessments of biodiesel production including feedstocks, production processes and use of the biofuel.

For more information:
vehiclefuels.gc.ca

Alternative Transportation Fuels: **Canadian Transportation Fuel Cell Alliance**

Objective: To demonstrate and evaluate different processes for the production and delivery of hydrogen to fuel cell vehicles at fuelling stations and to participate in the development of codes and standards.

The Canadian Transportation Fuel Cell Alliance (CTFCA) is a private-public sector initiative composed of technology developers, fuel providers, auto manufacturers, federal and provincial/territorial governments, academia and non-governmental organization representatives. The CTFCA's work contributes to a reduction in GHG emissions by encouraging advancements in hydrogen and fuel cell technologies through demonstration projects that evaluate the technical, economic and environmental feasibility of different hydrogen fuelling options for fuel cell vehicles. The initiative also establishes a supporting framework for hydrogen fuelling by assisting in the development of codes and standards as well as certification and training programs.

Key 2003–2004 Achievements

- Commissioned prototype fuelling station and upgraded operating fuelling stations.
- Ongoing codes and standards activities at a national and international level and produced draft hydrogen installation code for Canada.
- Assessment and evaluation of fuelling pathways is ongoing and several studies are underway or completed.

For more information:
nrcan.gc.ca/es/etb/ctfca/index.html

Alternative Transportation Fuels: **Hydrogen Economy and Transportation Energy Program**

Objective: In partnership with industry, to develop and deploy leading-edge hydrogen and transportation technologies that reduce GHG emissions, minimize other environmental impacts, increase the potential for job and economic growth and extend the life span of Canada's energy resource base.

Program staff work with stakeholders in the domestic and international hydrogen and transportation industries, including original equipment manufacturers, industry associations, fleet managers, transit authorities, utilities, provincial and territorial governments, research organizations, universities, other federal departments, the U.S. Department of Energy and the International Energy Agency.

Highlights of the Hydrogen Economy and Transportation Energy Program's work include:

- Supporting Canadian industry in developing a world-leading water electrolysis technology for the production of hydrogen from clean renewable energy sources.
- Working in partnership with Canada's fuel cell industry over the last 15 years, which has established Canada as a world leader in fuel cell and refuelling technologies; for example, the world's first hydrogen fuel cell bus was demonstrated in Canada.
- Supporting student vehicle challenges since the 1980s, and bringing university and college students from across North America together with automotive manufacturers to modify existing vehicles to run on a variety of alternative fuels. The program has also supported the development of alternative transportation fuel technologies, for example, for natural gas and propane vehicles, which has led to a Canadian industry that is now exporting commercial products.

Key 2003–2004 Achievements

- Organization and sponsorship of world-class conferences, including the 2003 Canadian Hydrogen and Fuel Cells Conference and Trade Show.
- Demonstration of a 10-kilowatt fuel cell power module, suitable for off-road mobility applications, in a vehicle.
- A 5000-psi (pounds per square inch) hydrogen storage cylinder was certified, and 300 of these cylinders were sold.
- Two companies licensed and commercializing natural gas engine control systems developed by the Saskatchewan Research Council.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_tet_e.html

Chapter 8: Renewable Energy

Renewable Energy Use

In 2002, renewable energy generation capacity from renewable sources accounted for 61 percent of total Canadian electricity capacity (see Table 8-2). Most of the renewable energy used in Canada comes from either hydro-electricity or thermal energy from biomass such as wood-waste sources.

Hydro-Electricity

Hydraulic power is a renewable energy based on the water cycle – evaporation, precipitation and flow of water toward the ocean. Canada has abundant water resources, and its geography provides many opportunities to produce low-cost energy. Tapping the energy from moving water has played an important role in the economic and social development of Canada for the past three centuries.

In 2003, hydro power accounted for about 60 percent of total electricity generation. Small-scale hydro-electric projects, with a capacity of 20 megawatts or less, constitute about 4 percent of Canada's electricity-generating capacity. Small-scale hydro has good potential for increased production.

Biomass

Bioenergy is a renewable source of energy derived from organic substances known as biomass. Biomass is supplied by agricultural wastes (such as chaff, straw, grain screenings, husks and shells, food-processing residues and methane) and forestry wastes (such as logging slash, sawdust, black liquour from the pulping process and other industrial waste). Other biomass supplies include animal litter and manure, landfill gas methane, urban wastes to be incinerated and sewage for biogas. Bioenergy contributes about 6 percent of Canada's primary energy, mostly for industrial process heat, electricity generation and residential space heating. Corn and other agricultural products are also used to generate ethanol and biodiesels for the transportation market.

TABLE 8-1

Renewable Energy Markets and Technologies Used in Canada

Electricity	*Thermal Energy*
Hydro-electricity	Biomass (e.g. roundwood, pellets, wood chips)
Tidal power	Ground-source heat pumps (e.g. earth energy)
Biomass (e.g. wood waste)	Solar air-heating systems
Biogas (e.g. methane from landfill sites)	Solar hot-water systems
Wind turbines	
Photovoltaic systems	
Mechanical Power	*Transportation*
Wind water pumps	Ethanol from biomass

TABLE 8-2

Electricity Generation Capacity From Renewable Sources (Includes Hydro)

Year	*Renewable electricity generation capacity (MW)*	*% of total capacity*
2002	71 527	61
2001	71 163	61
2000	68 986	62
1999	68 686	62
1998	68 340	62
1997	68 202	61
1996	67 101	59
1995	66 542	57
1994	63 175	56
1993	63 114	56
1992	62 895	58
1991	61 116	58
1990	59 557	58

Bioenergy production represents Canada's second largest renewable energy source. Most bioenergy is produced from organic refuse and used with the facilities in which the energy conversion takes place. The pulp and paper industry produces and uses most of Canada's bioenergy. Industrially produced heat and electricity, independent power producers' electricity, electricity from urban wastes and residential wood heat are all considered commonplace in Canada's energy mix.

Home heating with wood usually takes the form of stand-alone wood stoves, wood furnaces with hot-water or forced-air systems, fireplaces with advanced combustion inserts, high-efficiency fireplaces or high-thermal-mass masonry heaters. About 3 million Canadian households use wood for home heating. Canadians usually prefer roundwood, but alternatives include wood chips and pellets.

Earth Energy

As a result of the sun heating the surface of the planet, the temperature of the earth that is one or two metres below the surface remains fairly constant – between 5°C and 10°C. This is warmer than outside air during the winter and cooler than outside air during the middle of summer. A ground-source heat pump takes advantage of this temperature difference by using the earth or the ground water as a source of heat in the winter and as a "sink" for heat removed from indoor air in the summer. For this reason, ground-source heat pumps are known as earth energy systems (EESs).

During winter, EES installations remove heat from the earth using a liquid, typically an antifreeze solution, that circulates within an underground loop. It then upgrades the heat with a conventional heat pump and transfers it to indoor space or the water-heating system. During summer, the system reverses this process to operate as an air conditioner. EES installations supply less than 1 percent of the market for space and water heating and cooling in Canada.

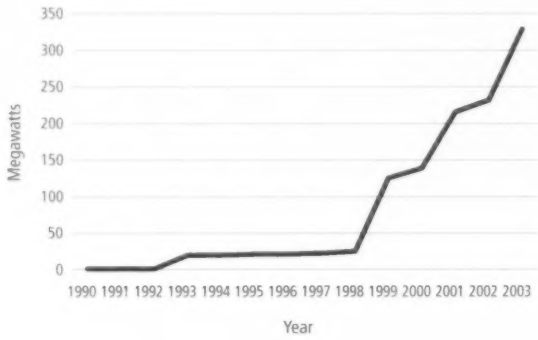
Wind Energy

Wind turbines convert the kinetic energy of wind into electrical or mechanical energy. Canada has a large wind resource potential because of its large size and northern location. A 1992 study by Natural Resources Canada (NRCan) estimated the technical wind energy potential in Canada at about 28 000 megawatts. If developed, this could supply 11 percent of total Canadian electricity consumption. In 2003, wind energy accounted for less that 1 percent of Canada's total electricity generation.

Wind energy also provides mechanical power. Several thousand wind-powered water pumps are used throughout Canada, mostly in the Prairie Provinces. As well, Canadians use small, residential-sized wind turbines to power cottages and remote houses (see Figure 8-1).

Figure 8-1

Canadian Wind Power Capacity, 1990 to 2003



Solar Energy

Three main technologies use energy from the sun:

- passive solar technologies is a term that means buildings are designed and located to maximize their reception of solar energy.
- active solar thermal systems convert solar radiation into thermal energy for heating air or water in residential, commercial and industrial applications.
- solar electric (photovoltaic) systems use solar radiation to produce electricity.

During the 1990s, NRCan assisted a Canadian company in developing a perforated solar absorber to preheat ventilation air and reduce a building's fuel requirements for space heating. This technology is more cost-effective than conventional solar air-heating technologies and is gaining acceptance in Canada and abroad. Systems have been installed on industrial and commercial/institutional buildings throughout Canada.

The installed photovoltaic power capacity in 2003 was 11.75 megawatts, with an estimated annual production of 10 gigawatt hours of electricity. The bulk of this capacity is "off grid" (not connected to an electrical transmission system), where the price of photovoltaics is competitive with conventional stand-alone power systems or an extension of a grid to a given location.

Typical applications include telecommunications systems, water pumping and purification, remote monitoring and control, remote residences, lighting and beacon systems for the Coast Guard, and numerous consumer applications, such as hand-held calculators. The Canadian Coast Guard is the largest individual user of photovoltaic systems in Canada, with an estimated 7000 navigational buoys, beacons and lighthouses.

Canada has more than 100 grid-connected photovoltaic systems installed on residential rooftops and buildings, providing on-site power with a combined capacity of just over 400 kilowatts. Significant reductions in equipment costs were observed, with Canadian photovoltaic panel prices decreasing to $6.18 per watt in 2003 compared with $11.09 per watt in 1999 (an average reduction of 15 percent per year).

NRCan delivers several initiatives to increase the use of small-scale renewable energy in Canada. The following is the array of NRCan renewable energy programs.

Renewable Energy Programs: **ENergy from the FORest (ENFOR)**

Objective: To improve the understanding of the role of biomass production for energy and to improve biomass productivity from natural forests and from plantations growing willow and poplar.

ENFOR, managed by the Canadian Forest Service (CFS) of NRCan, undertakes research and development (R&D) on the production and harvesting of forest biomass for energy through the private sector, universities or CFS research centres. ENFOR also investigates the broader environmental effects of harvesting from forests and short-rotation plantation culture, focusing on sustaining forest productivity and improving the sequestration and storage of atmospheric carbon in forest ecosystems. ENFOR also supports research on information systems to determine the quantity and quality of biomass in Canadian forests.

Key 2003–2004 Achievements

- Several species/varieties of willow and poplar have been assessed for production in Ontario, Quebec and the Prairie Provinces. Plantation establishment has been successful in many regions, and industry in western Canada is now engaged in the large-scale planting of fast-growing poplars.
- The CFS, the Canadian signatory to the International Energy Agency (IEA) Bioenergy Agreement, continued its collaboration with a series of workshops, seminars and publications.
- The IEA publication *Biofuels for Transport* describes the activities of tasks working on production of fuels from raw biomass processed into a more convenient form to be used as a fuel. It includes liquid biofuels, wood pellets and briquettes. The position paper *Municipal Solid Waste and its Role in Sustainability* describes the use of household and commercial waste in the energy mix, and the opportunities presented by this energy source.
- Major successes include the further development of the Forest Biomass Inventory of Canada; the modelling of whole-tree harvesting/nutrient cycling; the Carbon Budget Model of the Canadian Forest Sector; and the development and testing of species, clones and the establishment and fertilization of energy plantations.
- The publication *Sustainable Production of Woody Biomass for Energy* by Peter J. Hall was presented at the World Forestry Congress, Québec City, September 2003.

For more information:
nrcan.gc.ca/cfs-scf/science/resrch/bioenergy

Renewable Energy Programs: Initiative to Purchase Electricity From Emerging Renewable Energy Sources

Objective: To purchase electricity from emerging renewable energy sources (ERES) that are certified by a third party as having low environmental impact, with the objective of reducing greenhouse gas (GHG) and other air pollution emissions associated with federal electricity consumption.

Between 1998 and 2001, NRCan entered into three pilot projects to purchase electricity from ERES for federal facilities in Alberta, Prince Edward Island and Saskatchewan. NRCan has pledged to purchase 20 percent of its electricity from ERES by 2010.

Key 2003–2004 Achievements

- The Government of Canada received its second full year of electricity from ERES in Saskatchewan and Prince Edward Island. An estimated 32.4 gigawatt hours (GWh) of electricity from ERES were delivered to the grid in Saskatchewan as well as 13 GWh in Prince Edward Island. These projects resulted in an estimated emissions reduction of 29 000 tonnes of GHGs in Saskatchewan and 11 000 tonnes in Prince Edward Island.
- NRCan also continued to receive 10 000 GWh of electricity from ENMAX Corporation in Alberta. This purchase resulted in GHG emissions reductions of about 9000 tonnes annually.
- The governments of Prince Edward Island and Saskatchewan are purchasing electricity from ERES for their facilities.
- SaskPower constructed a second wind farm in Saskatchewan in fall 2002. This wind farm provides electricity for SaskPower facilities, provincial government facilities and SaskPower's "green" power purchases.
- The governments of Ontario and Alberta committed to purchasing electricity from renewable sources. Ontario targeted 20 percent of its electricity use, and Alberta entered into long-term contracts for 210 GWh annually.
- The Government of Canada issued a Request for Proposals (RFP) in Ontario for the purchase of 90 GWh of electricity from renewable resources, annually, for a period of five years. The RFP closed on December 12, 2003, and the evaluation of the proposals was underway at the end of the fiscal year with a contract award expected early next fiscal year.
- The Government of Canada also initiated or continued negotiations with NB (New Brunswick) Power, Nova Scotia Power and Newfoundland and Labrador Hydro for the purchase of additional quantities of electricity from renewable resources in their respective provinces.

For more information:
nrcan.gc.ca/redi

Renewable Energy Programs: **Photovoltaic and Hybrid Systems Program**

Objective: To support the development and application of solar photovoltaic technologies and the integration of distributed energy resources to the electrical grid in Canada.

The program contributes to increasing the use of photovoltaic energy technologies in Canada by developing technologies and by facilitating the development of a Canadian-based globally competitive solar industry. It also contributes to the development of policies and programs. In collaboration with Canadian industry and universities as well as international energy research organizations, the program undertakes research and development activities and fosters information exchanges that will encourage the adoption of photovoltaic-hybrid systems that produce electricity from solar energy and another energy source; validates the performance and safety of utility-interactive inverter products; supports the development of building-integrated photovoltaic technologies and systems; and facilitates the development and adoption of harmonized standards and codes for photovoltaic and distributed generation systems in Canada.

Key 2003–2004 Achievements

- Initiated a partnership with Xantrex Technology Inc. to develop and demonstrate a multi-energy (hybrid) technology that will combine and integrate several types of renewable energy (photovoltaic/wind/fuel cell) into a single system with a generator. The system offers an effective alternative energy solution that decreases GHG emissions by reducing fossil fuel use.
- Co-hosted a workshop, in collaboration with the Yukon Energy Solution Centre, to demonstrate the viability of the use of renewable energy in off-grid residences in Canadian northern communities.
- Championed a national initiative to facilitate the acceptance of utility-interactive inverters and simplified grid-interconnection requirements for renewable energy generation to become part of the electricity supply in Canada.

For more information:
cetc-varennes.nrcan.gc.ca/en/er_re.html

Renewable Energy Programs: **RETScreen® International Clean Energy Decision Support Centre**

Objective: To build the capacity of planners, decision-makers and industry to implement renewable energy and energy efficiency projects.

This objective is achieved by developing decision-making tools that reduce the cost of pre-feasibility studies, by disseminating knowledge to help people make better decisions, and by training people to better analyse the technical and financial viability of possible projects.

Key 2003–2004 Achievements

- Increased the number of users of the RETScreen International Clean Energy Project Analysis Software to more than 43 000 people in 200 countries and trained 1123 planners, decision-makers, professors and other professionals via the delivery of 28 RETScreen training seminars across Canada and 11 internationally with a number of partners.
- Released Version 3.0 of the RETScreen Wind Energy and Small Hydro Project Models in partnership with the World Bank's Prototype Carbon Fund and the United Nations Environment Programme, which incorporates an improved GHG emissions baseline tool to account for the emerging rules under the Kyoto Protocol.
- Developed a new Combined Heat and Power (CHP) Model for RETScreen, and initiated the development of a new Refrigeration Project Model for applications such as supermarkets and ice rinks.

For more information:
www.retscreen.net

Renewable Energy Programs: **Bioenergy Technology Program**

Objective: To support efforts by Canadian industry to develop bioenergy technologies.

Technologies supported include combustion, biochemical conversion of biomass to ethanol, thermochemical conversion of biomass to bio-oil and biogas, and biomass preparation and handling. Activities are directed toward improving the reliability and lowering the cost of technologies, disseminating information on technology feasibility and economics to potential users, and helping industry commercialize its products in domestic and foreign markets.

Key 2003–2004 Achievements

- With ongoing support from NRCan and other federal departments, Iogen Corporation is continuing on a successful path to full-scale commercialization of its process for producing fuel ethanol from agricultural residues, such as straw. Iogen Corporation successfully doubled its capability to produce fermentable sugar from wheat straw in its pre-commercial demonstration plant. The company can now process 50 tonnes per week of wheat straw to sugars and is on target to produce over 700 000 litres of ethanol annually.
- NRCan supported the University of Toronto (U of T) in the development of an innovative technology that can convert any seed oil, waste grease, and animal fat and tallow into high quality biodiesel fuel. The technology produces biodiesel at ambient pressure and low temperature to yield a superior product at a significant cost reduction, both in capital cost and operational cost. U of T licensed the process to the BIOX Corp. of Oakville, Ontario, which successfully demonstrated in a million-litres-per-year pilot plant that the process can cost-effectively convert high fatty acid feedstocks into biodiesel. BIOX also recently received support from the Sustainable Development Technology Canada (SDTC) program to build a 60-million-litres-per-year commercial demonstration plant.
- Canadian biomass companies have received funding support from agencies such as SDTC, the Federation of Canadian Municipalities, Technology Partnerships Canada and provincial/territorial agencies to build the first industrial demonstrations of pyrolysis technologies that will convert wood residues to heat, power and electricity. The successful demonstration of these processes – that have higher conversion efficacies than straight combustion systems – will help to accelerate their introduction into the energy field.
- Earth (Canada) Corporation was hired by the City of Edmonton to evaluate all gasification technologies worldwide to determine their technical and economic suitability for a municipal solid waste application for the city – 150 international technologies were reviewed, 11 were found to be technically acceptable. Enerkem Technologies, based in Sherbrooke, Quebec, was ranked in the top three technologies overall and was also ranked first for the lowest-cost technology.

For more information:
www.canren.gc.ca/bio/index.asp

Renewable Energy Programs: Renewable Energy Deployment Initiative (REDI)

Objective: To stimulate the demand for renewable energy systems by helping the supply industry in its marketing and infrastructure development efforts, including the provision of financial incentives.

REDI targets four systems: solar water heating, solar air heating, earth energy, and high-efficiency, low-emissions biomass combustion. REDI promotes these systems in the business, federal and industrial markets through three means: a financial incentive, market assessment, and information and awareness.

Key 2003–2004 Achievements

- Distributed $2.5 million in REDI financial incentives among 89 projects valued at $22 million; the projects were completed in 2003–2004.
- Collaborated with the Association of Canadian Community Colleges to support the development of a national renewable energy training strategy to be delivered across the college and institute network.
- Sponsored a renewable energy course for architects in partnership with the Royal Architectural Institute of Canada.
- Supported innovation by expanding the list of technologies supported to include another solar air-heating technology and paid for its testing at the National Solar Test Facility.
- In collaboration with the Canadian Electricity Association and the Geothermal Heat Pump Consortium, Inc., signed a contribution agreement to establish the Canadian GeoExchange Coalition to promote earth energy in Canada.
- In collaboration with industry partners, produced several new publications on renewable energy, including *Micro-Hydropower Systems – A Buyer's Guide; Performance Directory of Solar Pool Collectors;* and *REDI, Set, Go – Toolkit for Municipalities.*

For more information:
nrcan.gc.ca/redi

TABLE 8-3

REDI for Business Projects Completed, 1998 to 2004

	Number of projects completed	*Estimated GHG reduction (tonnes CO_2/yr.)*	*Cost of system*	*NRCan contribution*
1998–1999	8	2869.0	$1,306,295	$145,950
1999–2000	9	260.8	$479,633	$119,910
2000–2001	24	5825.4	$1,849,918	$327,078
2001–2002	43	21.7	$5,827,561	$1,197,965
2002–2003	33	5718.8	$2,745,834	$606,210
2003–2004	89	39 653.5	$22,356,375	$2,551,845
Total	**206**	**54 349.2**	**$34,565,616**	**$4,948,958**

Renewable Energy Programs: Renewable Energy Technologies (RET) Program

Objective: To promote energy diversity and support efforts by Canadian industry to develop renewable energy technologies.

This program supports the continued improvement of the economics and efficiency of renewable energy technologies. Technologies supported include bioenergy (combustion, biochemical conversion of biomass to ethanol, thermochemical conversion of biomass to bio-oil and biogas, and biomass preparation and handling), small hydro projects (less than 20 megawatts), active solar applications and wind energy.

Canada is a world leader in the production of renewable energy, with about 18 percent of its primary energy supply coming mainly from two sustainable sources: water (12 percent) and biomass (6 percent). Emerging renewable energy sources such as wind power and solar energy, both for heating and electricity generation, are rapidly gaining in importance and acceptance by utilities and industry.

Key 2003–2004 Achievements

- Funded work toward the development of new and improved engineering designs of small (less than 20 megawatts) hydro power plant equipment to increase efficiency and reduce costs.
- Helped establish an independent hydro turbine testing laboratory at Université Laval that provides research support to hydro turbine manufacturers such as GE Hydro and NORCAN Hydraulic Turbine Inc.
- Played a key role in establishing the manufacturing of efficient and cost-competitive small wind turbines (in the 10–275 kilowatt range) in Canada.
- Supported a project to further develop and improve the Wind-Diesel Integration Control (WDIC) system that now includes wind-diesel hybrid systems for remote communities also using hydrogen, biogas and batteries.
- Supported Frontier Power Systems of Prince Edward Island's installation of a wind/diesel project on Ramea Island, Newfoundland and Labrador, the first installation of this kind in Canada – a project that will reduce carbon dioxide (CO_2) emissions by about 750 tonnes per year.

For more information:
canren.gc.ca

Renewable Energy Programs: **Wind Power Production Incentive (WPPI)**

Objective: The WPPI is a 15-year, $260-million program to support the installation of 1000 megawatts of new wind energy capacity by March 31, 2007.

The WPPI encourages electric utilities, independent power producers and other stakeholders to gain experience in wind power, an emerging energy source. The incentive is approximately $0.01 per kilowatt hour of production and represents about half of the current cost of the premium charged for wind energy in Canada for facilities where good wind resources exist. Eligible recipients can receive the incentive for 10 years.

By displacing other electricity sources and through continued momentum, wind-power capacity installed under the WPPI is projected to reduce GHG emissions by 3 megatonnes annually by 2010.

Key 2003–2004 Achievements

- The program received 39 additional letters of interest for 2800 megawatts of wind-energy projects from developers, utilities and businesses. By the end of the fiscal year, four new projects were completed, for a total new capacity of about 15 megawatts. Two projects were in Prince Edward Island (8.3 megawatts), one in Saskatchewan (4.6 megawatts), and one in Quebec (2.3 megawatts) resulting in a commitment of more than $5.1 million of incentive payments over 10 years.
- Developed guidelines to assist wind developers, utilities and businesses in their submission of an Environmental Impact Statement under the *Canadian Environmental Assessment Act*. The *Environmental Impact Statement Guidelines for Screenings of Inland Wind Farms* are available from the program or on the WPPI Web site.

For more information:
canren.gc.ca/wppi

Renewable Energy Programs: **Market Incentive Program (MIP)**

Objective: The MIP is a $25-million program to stimulate emerging markets for renewable electricity. Funding is available until March 31, 2006.

Under the program, electric utilities, retailers and marketers submit proposals for consideration by NRCan and Environment Canada for projects to develop market-based programs and promote the sale of electricity from emerging renewable sources, having low environmental impact, to residential and small-business customers. The Government of Canada is to provide a short-term financial incentive of up to 40 percent of the eligible costs of an approved project, to a maximum contribution of $5 million per recipient.

The program's CO_2 reduction objectives are 1.4 megatonnes per year by 2010.

Key 2003–2004 Achievements

- Received 19 new proposals.
- Signed three contribution agreements with New Brunswick, Ontario and Prince Edward Island. The agreements could result in 28 715 new customers, 136 000 megawatt hours of incremental electricity and 107 kilotonnes of CO_2 emission reductions by 2006.
- Eight additional contribution agreements under negotiation.

For more information:
www2.nrcan.gc.ca/es/erb/erb/english/View.asp?x=457

Chapter 9: Federal House in Order

Introduction

The Government of Canada is the country's largest single enterprise. It is working to get its house in order by setting a target of a 31 percent reduction in greenhouse gas (GHG) emissions from its own operations by 2010.

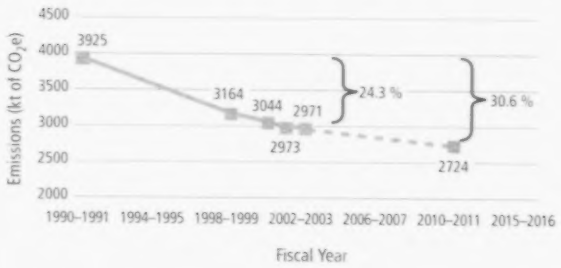
Since 1990, through building retrofits, better fleet management, strategic "green power" purchases and the downsizing of operations, the Government of Canada has already achieved a 24 percent emissions reduction. The Government of Canada will reduce its net emissions by a further 12 percent by 2010.

The Government of Canada will achieve its goal by additional building retrofits, fuel switching, improved fleet management, energy-efficient procurement and increased use of renewable energy within government operations. Moreover, the Government of Canada can help to "create the market" for certain new technologies on the verge of becoming viable. Key departments, which are responsible for 95 percent of government GHG emissions, have been assigned specific targets and must report annually on their progress.

The task of target sharing entails assigning specific targets to the 11 largest emitting departments based on the emission-reduction opportunities identified within each organization. Natural Resources Canada (NRCan) is taking a lead role in managing this task and in providing programs and support to departments and agencies that will help them achieve their targets. A leadership component of the Federal House in Order encourages the reduction of all federal emissions by engaging the active participation of the departments, agencies and Crown corporations that were not designated with a target.

FIGURE 9-1

GHG Emissions Reductions From Federal Operations, 1990–1991 to 2010–2011



Federal Buildings Initiative (FBI)

Objective: To assist Government of Canada organizations in implementing energy efficiency improvements, leading to reduced energy use, GHG emissions and operating costs.

The FBI facilitates comprehensive energy efficiency upgrades and building retrofits for departments, agencies and Crown corporations of the Government of Canada. The FBI provides advice and consultation on project opportunities, model performance contracting documents, celebration and recognition opportunities, and a national network for energy management training. In facilitating public-private partnerships, the FBI manages a qualified list of energy management firms that provide a turnkey service to federal organizations including project engineering and construction, third-party private sector financing, project monitoring, and employee training and awareness. FBI program officers work with federal organizations from project inception through to contract award and project monitoring and verification.

Key 2003–2004 Achievements

- Five new FBI contracts were awarded.
- The private sector invested $25.6 million in FBI projects.
- Average energy intensity improvement of 20 percent by project.

For more information:
oee.nrcan.gc.ca/fbi/home_page.cfm

Federal Industrial Boiler Program (FIBP)

Objective: To provide technical and project management services to assist federal facilities in implementing energy-reduction projects.

The FIBP's extensive experience in building energy systems and access to the engineering and scientific network within the CANMET Energy Technology Centre ensures that environmentally responsible technologies are considered when federal government clients replace or modify their space heating and cooling systems. Since its inception in 1991, the FIBP has worked with many departments, including Agriculture and Agri-Food Canada, Correctional Service Canada (CSC), the Department of National Defence, Environment Canada, and the Department of Foreign Affairs and International Trade (now divided into Foreign Affairs Canada and International Trade Canada), to reduce their energy costs. Under the FIBP, GHG emissions are reduced by an average of 4.7 kilotonnes per year.

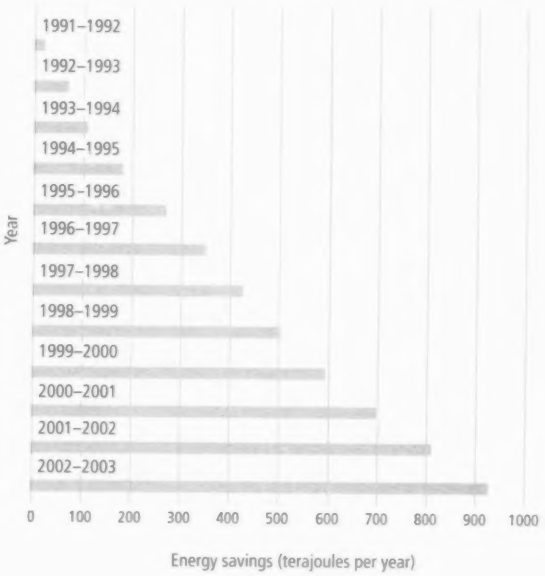
Key 2003–2004 Achievements

- Worked with Agriculture and Agri-Food Canada, CSC, NRCan, and Public Works and Government Services Canada to develop project proposals for the Federal House in Order initiative. The projects included wind turbines, ranging in size from 20 to 1000 kilowatts, a Solarwall® application, an innovative heating, ventilation and air-conditioning (HVAC) heat recovery system, and improved building heating achieved by converting to local high efficiency heaters. Five projects were approved for funding. Once implemented, they will reduce annual carbon dioxide emissions by 668 000 kilograms.
- Worked with CSC sites in the Kingston, Ontario, area to review heating plant operations and develop options to reduce operating costs and environmental emissions. Thirty-year life cycle costs of various options were developed for Kingston Penitentiary and Collins Bay Institution. These identified options that could reduce annual operating costs by $230,000 and $200,000, respectively.
- Reviewed CSC's Springhill Institution heating plant operation and developed a plan for upgrading controls for fully automatic operation. Implementation proceeding in fiscal year 2004–2005.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/research_programs_fibp_e.html

FIGURE 9-2

Annual Energy Savings From the FIBP, 1991–1992 to 2002–2003



Federal Vehicles Initiative

Objective: To assist federal government departments in increasing the energy efficiency of their motor vehicle fleets and reducing the environmental impact of federal vehicle operations and to promote the *Alternative Fuels Act* within the federal fleet.

The Initiative provides fleet managers with an assessment of fleets as well as technical advice and encouragement on acquiring and using alternative transportation fuels. Four departments participate in planning and reporting on the Initiative: Environment Canada, NRCan, Public Works and Government Services Canada, and Treasury Board of Canada Secretariat. NRCan is responsible for implementing the program.

Key 2003–2004 Achievements

- Established three new alternative fuel sites; two additional sites are under construction.
- Trained 1445 federal vehicle operators at workshops; trained an additional 205 operators on-line.
- Acquired 377 Leadership Vehicles, 293 of which were alternative fuel vehicles, in compliance with the *Alternative Fuels Act*.

For more information:
oee.nrcan.gc.ca/greening/home.cfm

FIGURE 9-3

Federal Fleet Size and Fuel Consumption, 1995–1996 to 2002–2003

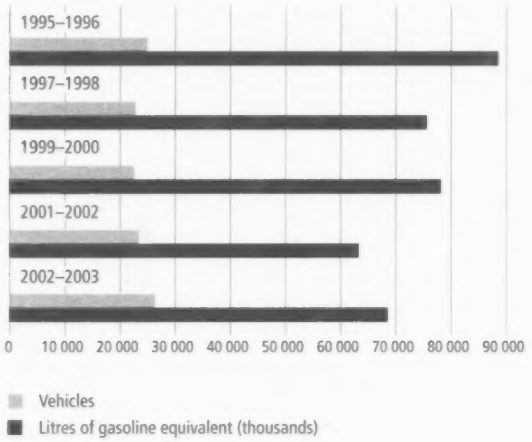
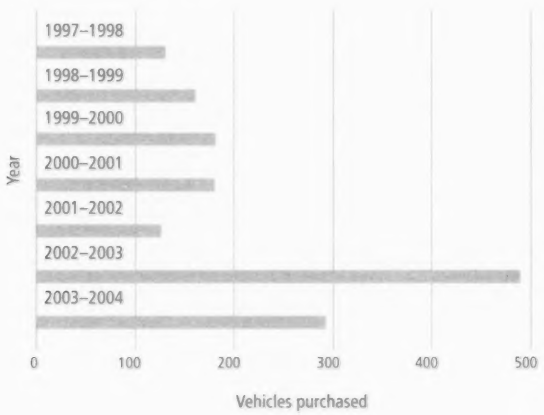


FIGURE 9-4

Purchases of Alternative Fuel Vehicles for the Federal Fleet, 1997–1998 to 2003–2004



Chapter 10: General Programs

Outreach

Objective: To increase Canadians' awareness and understanding of climate change and the link to energy use, and to encourage Canadians to take action.

The Outreach program provides information and activities to encourage Canadians to integrate energy efficiency into their energy-use decisions. Outreach supplements program communications activities with publications, exhibits, joint projects and the Office of Energy Efficiency (OEE) Web site.

The Outreach program targets youth as future energy consumers by investing in joint initiatives in the education sector and through promotional projects. Public information activities increase awareness of the environmental impact of energy use. They also encourage consumers to adopt energy-efficient practices and to switch to alternative forms of energy.

As a component of the Outreach program, the One-Tonne Challenge was launched in March 2004. The One-Tonne Challenge is co-managed with Environment Canada, with input from and coordination with other departments, such as Transport Canada. The One-Tonne Challenge asks Canadians to reduce annual greenhouse gas emissions by one tonne. Canadians are challenged to use less energy, to reduce waste and to conserve water and other resources. Reduced emissions will protect the climate and result in cleaner air and healthier communities for all Canadians.

Key 2003–2004 Achievements

- Increase of 30 percent in the volume of publications distributed and a 300 percent increase in Web site visits, indicating increasing interest in energy efficiency.
- Baseline polling indicated that 81 percent of Canadians believe that their actions to increase energy efficiency will pay off.
- *Energy and the Environment* calendar (7072 submissions received – 144 000 calendars distributed) participation increased by 45 percent; visits to the Web site for the calendar increased (13 percent).
- Energy Ambassadors – Student Competition: 75 projects received – 19 awards presented to 38 students.
- Canada's Energy Efficiency Awards – 179 nominations received – 15 awards presented.
- OEE extended six provincial/territorial co-funded Public Education and Outreach Hubs for two years.
- Climate change educational material has been linked to provincial curricula across Canada and workshops are underway to reach elementary and secondary teachers.

For more information:
oee.nrcan.gc.ca/corporate/programs.cfm#outreach

Program of Energy Research and Development (PERD)

Objective: To fund research and development (R&D) designed to ensure a sustainable energy future for Canada in the best interests of our economy and our environment.

The PERD budget for 2003–2004 was approximately $58 million. Natural Resources Canada (NRCan) allocated $41.5 million to energy R&D programs managed and performed in the department, approximately 50 percent of which contributed to improved energy efficiency in Canada. Examples of funded projects are included in the performance reporting in Chapters 4–8 of this report. The remaining $16.5 million was allocated to 10 federal departments that are partners in PERD.

For more information:
www2.nrcan.gc.ca/es/oerd/english/View.asp?x=665

Climate Change Technology Development and Innovation Program (of the *Government of Canada Action Plan 2000 on Climate Change*)

Objective: To accelerate the development of cost-effective R&D mitigation technologies in multiple sectors, building the intellectual foundation for long-term technological advances, building alliances and partnerships and demonstrating federal leadership towards sustainable development.

The Climate Change Technology Development and Innovation Program received $20 million over six years (2001–2006) as a part of *Action Plan 2000 on Climate Change*.

Key 2003–2004 Achievements

- Developed and demonstrated novel mitigation technologies in the second year of the Innovative Research Initiative, aimed at federal, provincial and territorial research organizations. A total of 33 R&D projects are nearing completion, and 15 new projects received incubation funding to undertake novel next-generation R&D.

For more information:
www2.nrcan.gc.ca/es/oerd/english/View.asp?x=658

International Initiative for Technology Development Program

Objective: To identify and develop technology transfer projects and facilitate the expansion of market opportunities for climate change technologies.

The International Initiative for Technology Development Program received $10 million over six years (2001–2006) as part of *Action Plan 2000 on Climate Change*.

Key 2003–2004 Achievements

- Provided funding to nine new feasibility studies.
- Launched the Clean Energy Portal and provided marketing support at five national and international conferences.
- Organized numerous outgoing and incoming missions to promote Canadian technology transfer.

Climate Change Technology and Innovation Research and Development and Innovation Program

Objective: To contribute to the *Climate Change Plan for Canada* objective to "advance promising GHG technologies through R&D, demonstration and early adoption initiatives to achieve long-term GHG reductions and strengthen Canada's technology capacity."

Implemented in 2003 with $115 million over five years of federal funding, T&I R&D is based on long-term strategic planning that takes into account expected energy futures and visions to the year 2025. R&D is conducted in the five strategic areas of cleaner fossil fuels, advanced end-use efficiency technologies, decentralized energy production (including renewables), biotechnology and the hydrogen economy.

The T&I R&D budget for 2003–2004 was $6.4 million. NRCan allocated $5.1 million to energy R&D programs managed and performed in the department. A targeted Request for Proposals focused on R&D, strategic and scoping studies, and infrastructure renewal. Key NRCan R&D achievements that contributed to improved energy efficiency in Canada are included in the performance reporting in Chapters 4–8 of this report. The remaining $1.5 million was allocated to six federal departments that are partners in T&I R&D.

Chapter 11: Intergovernmental Cooperation

Introduction

This chapter describes Natural Resources Canada's (NRCan's) intergovernmental cooperation with respect to efficiency and alternative energy (EAE) during the reporting period at the provincial/territorial and international levels. Other examples of intergovernmental cooperation are set out in previous chapters in the Key Achievements sections of specific EAE program initiatives. It also should be noted that municipal governments and agencies participate in NRCan's EAE measures as clients (e.g. for training workshops; as recipients of financial incentives) and partners (e.g. in anti-idling projects). NRCan also participates in ventures led by municipal organizations (e.g. Green Municipal Funds, as explained in the accompanying textbox) and provincially/territorially regulated electricity and provincially regulated natural gas utilities.

Green Municipal Funds

- The Green Municipal Funds were created in Budget 2000 by an endowment of $125 million to the Federation of Canadian Municipalities (FCM). The funds were doubled in Budget 2001 to the current total of $250 million – $50 million for the Green Municipal Enabling Fund and $200 million for the Green Municipal Investment Fund.
- The Government of Canada signed an Agreement with the FCM, a non-profit organization, to deliver the Green Municipal Funds. Under the agreement, the Government of Canada (NRCan and Environment Canada) shares in the governance of the Green Municipal Funds, along with representatives from the public and private sectors, including municipal officials and technical experts, through participation on a Peer Review Committee and a governing Council. The FCM Board of Directors reviews council recommendations and decisions.

Federal-Provincial and Federal-Territorial Cooperation

Provincial and territorial governments assisted the delivery of a substantial number of EAE programs during the reporting period to reduce energy costs, increase competitiveness, improve air quality and generate economic and trade opportunities. Coordination between the federal and provincial/territorial levels is essential to avoid duplication and ensure efficient program delivery. During the reporting period, the governments cooperated at the general level and at the level of specific program initiatives.

General Cooperation

Cooperation Agreements

- NRCan's Letter of Cooperation (LOC) on EAE with the Agence de l'efficacité énergétique du Québec during the reporting period ensures an efficient consultation and exchange of information between the two governments, and helps the coordination of EAE activities in the province and the creation of opportunities for joint projects. The management committee established under the LOC met during the year to review policy and program developments, progress on joint program initiatives and areas for further cooperation. The LOC played a considerable role in facilitating the conduct of three activities in particular:
  - management of the licensing agreement for delivery of EnerGuide for Houses.
  - the processing of projects submitted to the Energy Innovators Initiative and the Commercial Building Incentive Program by public organizations in Quebec. This cooperation framework is also being applied to other NRCan programs aimed at the public sector in Quebec.

- management of an agreement relating to the Programme d'intervention en réfrigération dans les arenas du Québec, under which NRCan has provided technical support for the implementation of innovative refrigeration systems in Quebec's ice rinks.

- NRCan's LOC on energy efficiency and renewable energy with the Government of Yukon facilitates information exchange and the creation of opportunities for joint projects in Yukon, including partnering with the Yukon Development Corporation to create the Canada-Yukon Energy Solutions Centre in Whitehorse. The Centre provides access to relevant technical services and programs for the Yukon population and undertakes outreach and public education activities.
- The Government of Canada contributes to the Arctic Energy Alliance to promote energy efficiency and renewable energy in the Northwest Territories and to facilitate opportunities for EAE projects. The Alliance also is the delivery agent in the Northwest Territories for the EnerGuide for Houses initiative.
- The Government of Canada promotes energy efficiency and renewable energy in Alberta by working with Climate Change Central, a not-for-profit corporation which is funded by a multi-stakeholder base, including the Government of Alberta.

National Advisory Council on Energy Efficiency (NACEE)

- NRCan created NACEE in April 1998 to advise and guide the Office of Energy Efficiency (OEE) on the most effective way to achieve its mission. Its membership is drawn from across Canada and all economic sectors, including provincial/territorial officials and representatives of electricity and natural gas utilities, who have the opportunity to comment on the OEE's business plan and programs. NACEE met three times during 2003–2004.

Examples of Cooperation at the Program Level

R-2000 Standard and EnerGuide for Houses

- The Government of Canada contributes towards the delivery of R-2000 and EnerGuide for New Houses by the Yukon Housing Corporation. The Corporation also delivers EnerGuide for Houses in the existing housing market in the territory.
- In New Brunswick, Newfoundland and Labrador, Nova Scotia and Saskatchewan, the provincial governments and NRCan supported R-2000 through financial or in-kind contributions. Saskatchewan also supports marketing of EnerGuide for Houses in that province.
- In Manitoba and Yukon, the provincial and territorial governments delivered R-2000 under a licensing agreement with NRCan.
- In Quebec, the Agence de l'efficacité énergétique du Québec has incorporated the R-2000 Standard into its Novoclimat Initiative. The Agence also coordinates the delivery of EnerGuide for Houses in the province.
- Manitoba Hydro has incorporated the R-2000 Standard and EnerGuide for Houses into its Power Smart initiatives.
- British Columbia Hydro offers a financial incentive for energy-efficient residential retrofits, based on the EnerGuide for Houses service.

Federal Buildings Initiative (FBI)

- British Columbia and New Brunswick have replicated several elements of the FBI into programs aimed at improving the energy efficiency and environmental performance of their buildings.

Commercial Building Incentive Program (CBIP)

- Provinces and territories distributed information on CBIP.
- Provincial and territorial health and education departments were active participants in the program as eligible parties.
- NRCan works with the Agence de l'efficacité énergétique du Québec to facilitate the participation of public organizations in the initiative.
- The province of Alberta, through the Energy Solutions Alberta initiative of Climate Change Central, implemented a pilot program providing additional financial incentives to projects approved by CBIP.
- The province of Saskatchewan announced a new policy mandating CBIP compliance for provincial buildings receiving at least 30 percent government funding.

Canadian Industry Program for Energy Conservation (CIPEC)

- NRCan collaborated with the Agence de l'efficacité énergétique du Québec, Hydro-Québec and Gaz Métro in Quebec; with Enbridge and Union Gas in Ontario; and with Manitoba Hydro and BC Hydro on funding industrial energy audits of companies within their jurisdictions. As well, provincial government and utilities in the provinces of Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Manitoba, Saskatchewan, Alberta and British Columbia collaborated with CBIP to deliver industrial energy efficiency information sessions.

Energy Innovators Initiative (EII)

- The EII relies on partners to promote energy efficiency and facilitate access to its members as well as to provide sectoral information. Partners include the Association of Canadian Community Colleges, the Canadian School Boards Association, the Canadian College of Health Service Executives, the Association des gestionnaires de parcs immobiliers institutionnels, and the Ontario Hospitals Association.
- A dynamic partnership has been established with BC Hydro to assist in identifying new retrofit projects with large energy users.
- EII established a collaboration with Hydro-Québec to hold joint promotional activities, as well as to explore ways to harmonize each party's programs.
- The EII works with the Agence de l'efficacité énergétique du Québec to facilitate program delivery to the province's institutional sector.

Equipment *Energy Efficiency Regulations* and Labelling

- NRCan and five provinces (British Columbia, New Brunswick, Nova Scotia, Ontario and Quebec) regulate the energy efficiency performance of prescribed equipment. They share information and consult through the Canadian Standards Association's Advisory Committee on Energy Efficiency.
- Incentive rebate programs for the purchase of ENERGY STAR® qualified equipment were conducted, in cooperation with NRCan, by BC Hydro and Terasen Inc. (British Columbia), Climate Change Central (Alberta), tne Province of Saskatchewan, Union Gas (Ontario), Enbridge Gas Distribution (Ontario) and Enbridge Gas New Brunswick.
- NRCan worked with Manitoba Hydro and the City of Winnipeg on a demonstration of the use of LED (light emitting diode) traffic lights in severe climates. It undertook a pilot program with British Columbia Hydro to promote the purchase and use of LED seasonal lights.

Initiative to Purchase Electricity From Emerging Renewable Energy Sources

- The February 2000 federal budget announced that the Government of Canada would expand the pilot Green Power Initiative to procure $15 million of renewable energy over the next 10 years in Saskatchewan and Prince Edward Island. By early 2001, agreements were reached with SaskPower and Maritime Electric on the purchase of "green" power for federal facilities in the provinces they serve.

Market Incentive Program for Distributors of Electricity From Emerging Renewable Energy Sources

- Announced in October 2002, this program provides a limited financial incentive towards projects aimed at developing market-based programs and promoting the sale of electricity from emerging renewable sources to residential and small-business customers. Agreements have been signed with Selectpower, a subsidiary of Guelph Hydro Inc. (Ontario), NB (New Brunswick) Power and Maritime Power (Prince Edward Island).

Residential Wood Combustion

- NRCan is a member of the Intergovernmental Working Group on Residential Wood Combustion, which includes representatives from municipal, provincial, territorial and federal governments. The Working Group was formed in 1999 to promote and coordinate government actions on the sustainable development of residential wood combustion. Its first priority was to address four components related to residential wood combustion under the Joint Initial Actions on the Canada-wide Standards for fine particulate matter ($PM_{2.5}$) and ozone. Under these actions, governments committed to participating in new initiatives to reduce emissions from residential wood-burning appliances, including:
  - an update of the Canadian Standards Association's standards for new wood-burning appliances

- development of a national regulation for new, clean-burning residential wood heating appliances
- national public education programs
- an assessment of the option of a national wood stove upgrade or change-out program

Personal Vehicles and Vehicle Fuels

- In Ontario, the Municipalities of Mississauga, Ottawa, Caledon and the Greater Toronto Area are active members of NRCan's vehicle anti-idling campaign. Other campaigns have been successfully completed in Calgary, Edmonton, Sherbrooke and Québec City.
- All provinces and territories have agreed to include fuel efficiency messaging provided by NRCan in their next version of basic drivers handbooks.
- NRCan co-chairs the federal-provincial/territorial Council of Energy Ministers' Working Group on Biofuels.

Program of Energy Research and Development (PERD)

- NRCan manages this 30-year program that funds energy research and development through 12 federal departments.
- Research and development is performed in federal facilities located across Canada and is also supported by the provinces/territories and industry.

Technology and Innovation Research and Development (T&I R&D)

- Announced in 2003 as part of the *Climate Change Plan for Canada*, this five-year interdepartmental initiative will accelerate the development of technologies to help achieve GHG reductions in the longer term.
- Energy efficiency will be a key element of energy R&D programs targeted in the areas of cleaner fossil fuels, advanced end-use efficiency technologies, decentralized energy production (including renewables), biotechnology and the hydrogen economy.

International Cooperation

NRCan cooperates with several international organizations and foreign governments in EAE program areas. Canada benefits from this cooperation:

- by learning about improved ways of designing and delivering EAE programs to meet policy objectives
- through the harmonization of energy efficiency tests and performance standards that helps reduce barriers to trade in energy-using products

International Energy Agency (IEA)

The IEA, based in Paris, France, is an autonomous agency within the framework of the Organisation for Economic Co-operation and Development. The IEA carries out a comprehensive program of energy cooperation among its 26 member countries, including Canada. IEA member governments have committed to sharing energy information, coordinating energy policies and cooperating in the development of rational energy programs. The IEA and its Governing Board are assisted in their work by several standing groups and special committees, which bring together energy specialists from member countries.

The Standing Group on Long-Term Cooperation (SLT) is the key committee on the policy side. It analyses policies to promote conservation and the efficient use of energy, the increased use of alternatives to oil and other measures to increase long-term energy security while protecting the environment. The SLT monitors energy developments in member countries and makes recommendations on energy policy through a regular series of individual country reviews. The Energy Efficiency Working Party (EEWP) of the SLT undertakes IEA work on specific issues related to energy efficiency. Canada is represented at the EEWP by NRCan's Office of Energy Efficiency. In 2003, the IEA conducted an in-depth review of Canada's energy policies, including EAE policies and measures.

NRCan is a member of the Centre for Analysis and Dissemination of Demonstrated Energy Technologies (CADDET), established under the IEA Agreement on Energy and Environmental Technologies Information Centres. CADDET is an international information network that helps managers, engineers, architects and researchers find out about energy-using technologies that have worked in other countries.

Canada also collaborates with research centres in member countries on several agreements and programs oriented toward R&D and technology. NRCan facilitates R&D and commercial business ventures abroad by Canadian firms by undertaking a wide variety of activities, including participating in various IEA tasks and supporting technical and trade-oriented workshops and conferences.

United Nations

RETScreen® International is managed under the leadership of NRCan's CANMET Energy Technology Centre – Varennes (CETC–Varennes) through cost- and task-shared collaborations with other governments and multilateral organizations, and with technical support from experts in industry, government and academia. Key partners are the United Nations Environment Programme's Energy Unit of the Division of Technology, Industry and Economics; Global Environment Facility-sponsored Sustainable Alternatives Network; Risoe Centre on Energy, Climate and Sustainable Development; and the Solar and Wind Energy Resource Assessment project. Other international partners include the World Bank's Prototype Carbon Fund; the National Aeronautics and Space Administration's Langley Research Center; the Barbados Ministry of Energy and Public Utilities; the United States Agency for International Development; and the Korean Institute for Energy Research.

China

In February 2001, Canada and China signed a Memorandum of Understanding (MOU) on Energy Cooperation. In January 2003, they signed an MOU on climate change and the Clean Development Mechanism. Energy efficiency is among the areas of cooperation identified in both MOUs.

The Federal Buildings Initiative of NRCan's OEE participated in a workshop on "government energy management programs" organized by the China Certification Center for Energy Conservation Product and the Lawrence Berkeley National Laboratory of the United States Department of Energy and held in Beijing, China. The event brought together leading experts in the field of energy efficiency management and government efficiency management.

Mexico

NRCan signed a MOU on EAE cooperation with the Mexican Energy Secretariat in June 1996. Its objective is to contribute to the EAE objectives of Canada and Mexico by improving the design and delivery of EAE programs and enhancing trade, investment and exchanges (technical and other) related to energy-efficient products, energy management services and alternative energy goods and services.

United States

NRCan and the U.S. Department of Energy (DOE) have an MOU on road transportation, energy efficiency and alternative fuels. It provides a formal mechanism for negotiating and harmonizing North American policy on fuel efficiency, fuel quality and alternative transportation fuels. The MOU provides a framework for joint projects and studies in areas of mutual interest, such as the costs and market potential of hybrid electric-powered and diesel-powered vehicles. The MOU facilitates bilateral discussion of a broad range of issues in the motor vehicle and fuels policy area and affords access to technology assessments and policy-related studies conducted for the DOE by its national laboratories. In 2003–2004, a study was begun on hybrid and diesel powertrains in the U.S. light-duty vehicle market. Diesel and hybrid technologies each have the potential to reduce light-duty vehicle fuel consumption by 25 percent or more without loss of performance, yet these technologies have typically been excluded from technical assessments of fuel economy potential on the grounds that hybrids are too expensive and diesels cannot meet Tier 2 emissions standards. The study takes a detailed look at the market potential of these two powertrain technologies and their possible impacts on light-duty vehicle fuel consumption.

United States and Mexico

NRCan continues to participate with the United States and Mexico in the North American Energy Working Group's (NAEWG's) Energy Efficiency Experts Group to promote the harmonization of energy efficiency test methods, mutual recognition of conformity assessment systems for energy efficiency standards and cooperation on trilateral energy efficiency labelling programs. During the review period, work was initiated to compare test standards for central air conditioners and transformers and other products. Mexico continued to review implementation of ENERGY STAR® and adoption of a new approach, developed in Canada and the U.S., for promoting the replacement of inefficient electric motors. A trilateral stakeholder meeting was held in conjunction with the annual meeting of the Council for the Harmonization of Electrotechnical Standards for the Nations of the Americas, which provided feedback on ways for more effective interaction between the group and the NAEWG.

Appendix 1: NRCan's Efficiency and Alternative Energy Initiatives and Expenditures, 2003–2004

	(millions of dollars)
Energy Efficiency – Equipment	**$22.0**
Energy Efficiency Standards and Regulations	
Equipment Labelling and Promotion	
EnerGuide for Industry	
Mine Ventilation	
Energy Efficiency – Housing and Buildings	**$41.5**
R-2000 Standard and EnerGuide for (New) Houses	
Super E™ House Program	
EnerGuide for Houses and Retrofit Incentives	
Housing Energy Technology Program	
Commercial Building Incentive Program	
Industrial Building Incentive Program	
Green Buildings Program	
Federal Buildings Initiative	
Federal Industrial Boiler Program	
Energy Innovators Initiative	
Buildings Program – Refrigeration Systems	
Buildings Program – Intelligent Buildings	
Building Energy Simulation Program	
Community Energy Systems Program	
Energy Efficiency – Industry	**$30.4**
Industrial Energy Efficiency (Canadian Industry Program for Energy Conservation; Industrial Energy Innovators)	
Cleaner Fossil Fuel Power Generation	
Processing and Environmental Catalysis Program	
Industrial System Optimization Program	
Industry Energy Research and Development Program	
Emerging Technologies Program	
Industrial Energy Innovation	
Minerals and Metals Program	

	(millions of dollars)
Energy Efficiency – Transportation	**$11.0**
Vehicle Efficiency	
Personal Vehicles	
Fleet Vehicles	
Federal Vehicles Initiative	
Canadian Lightweight Materials Research Initiative	
Alternative Energy – Transportation	**$17.0**
Fuel-Cell-Powered Mining Vehicles	
Future Fuels Initiative	
Ethanol Expansion Program	
Biodiesel Initiative	
Canadian Transportation Fuel Cell Alliance	
Hydrogen Economy and Transportation Energy Program	
Alternative Energy – Renewable Energy Sources	**$23.1**
ENergy from the FORest (ENFOR)	
Initiative to Purchase Electricity From Emerging Renewable Energy Sources	
Photovoltaic and Hybrid Systems Program	
RETScreen® International Clean Energy Decision Support Centre	
Bioenergy Technology Program	
Renewable Energy Deployment Initiative	
Renewable Energy Technologies Program	
Wind Power Production Incentive	
Market Incentive Program	
General Programs[1]	**$10.7**
Outreach	
National Energy Use Database	
Total[2]	**$155.62**

[1] Totals allocated for funding programs in Chapter 10 are reflected in the relevant program entries.
[2] Total does not add due to rounding.

Appendix 2: Data Presented in Report

The aggregate energy use data presented in this report are taken from Statistics Canada's *Report on Energy Supply–Demand in Canada* (RESD). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of RESD energy use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*, whereas this report uses a definition better suited for the purpose of energy end-use analysis. Some modifications to the original Statistics Canada data were required and are documented in Appendix B of NRCan's *Energy Use Data Handbook, 1990 and 1995 to 2002*.

FIGURE 2-1: Canada: Changes in Energy Intensity and the Energy Efficiency Effect, 1990 to 2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Intensity Index	1.00	1.00	1.00	1.00	0.99	0.98	1.00	0.96	0.91	0.89	0.87	0.84	0.84
Index of Energy Efficiency Effect	1.00	0.98	0.97	0.95	0.94	0.92	0.94	0.91	0.90	0.89	0.88	0.87	0.87

FIGURE 2-2: Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Estimated energy use without energy efficiency improvements	1.00	1.00	1.02	1.07	1.11	1.15	1.17	1.20	1.19	1.24	1.29	1.27	1.31
Actual energy use	1.00	0.98	1.00	1.01	1.05	1.07	1.11	1.11	1.09	1.12	1.17	1.14	1.18

FIGURE 2-3: Electricity Production from Renewable Sources (GWh)

1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3649	4134	4477	5362	5422	5855	6419	6599	7372	7418	7512

FIGURE 4-1: Canadian Households by Type of Dwelling, 2002

	Number of households	Percentage
Single detached	6 761 278	56
Apartments	3 753 855	31
Single attached	1 248 738	10
Mobile homes	257 138	2
Total	**12 021 009**	

FIGURE 4-2: Residential Energy Use by Purpose, 2002 (percent)

	Energy Use	Percentage
Space heating	830.8	59
Water heating	303.4	22
Appliances	181.5	13
Lighting	61.5	4
Space cooling	22.1	2
Total	**1399.4**	

FIGURE 4-3: Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Estimated energy use without energy efficiency improvements	1.00	1.04	1.10	1.14	1.15	1.17	1.23	1.21	1.13	1.18	1.25	1.22	1.28
Actual energy use	1.00	0.98	1.01	1.04	1.07	1.05	1.13	1.08	0.99	1.03	1.08	1.04	1.09

FIGURE 4-4: EnerGuide Rating for Houses Annual Heating Consumption for Houses Constructed to Different Standards

Description	EnerGuide for Houses Annual Heating Consumption (MJ)
Typical house built to R-2000 Standard	78 747
House built to Model National Energy Code (2002)	112 101
Typical new house (2002)	146 274
Typical existing house (1970)	216 812

Figure 4-5: Average Energy Consumption per Household, Pre-1946 to 2000–2004

Year Built	Average Energy (GJ) Consumption	EGH Rating
Pre–1946	295	45
1946–1960	220	58
1961–1970	211	61
1971–1980	202	63
1981–1990	191	66
1991–2000	167	70
2001–2004	156	73
All EGH in Canada	216	60
R-2000	100	82

FIGURE 4-6: Number of Eligible R-2000 Housing Starts, 1990 to 2003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Number of R-2000 Houses	495	699	1196	1299	783	611	416	484	265	213	316	320	419	378

FIGURE 4-7: National Trends in Air Leakage (R-2000 and EnerGuide for Houses), Pre-1945 to 2000–2004

Year Built	First EGH Evaluation (A)	Post-Retrofit Evaluation (B)	R-2000
Pre–1945	12	9	n.a.
1945–1959	9	7	n.a.
1960–1969	7	6	n.a.
1970–1979	7	6	n.a.
1980–1989	6	6	0.9
1990–1999	4	4	1.1
2000–2004	3	3	1.1
Average	8	7	1.1

FIGURE 4-8: Evaluations Under EnerGuide for Houses, 1998–1999 to 2003–2004

Year of EGH Evaluation	1998–1999	1999–2000	2000–2001	2001–2002	2002–2003	2003–2004
Houses evaluated but not re-evaluated (A evaluation)	3675	9111	11 510	11 088	16 564	48 260
Houses evaluated and retrofitted (B evaluation)	832	226	607	709	1153	2724

FIGURE 4-9: Residential Energy Use and Energy Savings per Household*, Pre-1945 to 2000–2004

	Pre–1945	1945–1959	1960–1969	1970–1979	1980–1989	1990–1999	2000–2004	Average
Energy use pre-evaluation	295	220	211	202	191	167	156	216
Evaluation-identified energy savings	122	83	74	67	54	29	19	74
Actual energy savings after renovations	75	52	46	45	40	33	35	51

* Gigajoules

FIGURE 4-10: Eighth Amendment: Estimated Reductions in CO_2 Emissions, 2005 to 2020

	2005	2010	2015	2020
Residential GHG Savings (Mt)	0.17	1.22	2.46	3.44

FIGURE 4-12: Average Energy Consumption of New Appliances, 1990 and 2002 Models

	1990	2002
Clothes washers	1218	779.24
Clothes dryers	1103	915.62
Refrigerators	956	506.27
Dishwashers	1026	592.04
Ranges	772	755.98
Freezers	714	367.66

FIGURE 4-14: Impact of EnerGuide Labelling: Total Energy Savings and GHG Emissions Reductions Attributable to the EnerGuide for Equipment Program, 1990 to 2000

Year	Total energy savings (GWh)	GHG reductions (kt CO_2E)
1990	16.4	8.9
1991	21.7	11.8
1992	40.1	21.7
1993	41.9	22.6
1994	43.2	23.4
1995	40.3	21.8
1996	43.7	23.7
1997	46.7	25.3
1998	62.4	33.8
1999	83.8	45.4
2000	91.1	49.3
Cumulative annual	**531.3**	**287.7**

FIGURE 5-1: Commercial/ Institutional Energy Use by Building Type*, 2002

	Energy Use	Percentage
Office	382.2	34
Retail organization	237.1	21
Health care institution	104.6	9
Hotel and restaurant	85.9	8
School	95.3	8
Recreational facility	70.5	6
Warehouse	70.2	6
Other institution	60.4	5
Religious institution	16.1	1
Total	**1 122.3**	

* Excludes street lighting

FIGURE 5-2: Commercial/Institutional Energy Use by Purpose*, 2002

End Use	Energy Use	Percentage
Space heating	604.59	54
Lighting	150.98	13
Auxilary motor	122.12	11
Auxilary equipment	99.65	9
Water heating	78.27	7
Space cooling	66.73	6
Total	**1122.34**	

* Excludes street lighting

FIGURE 5-3: Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Estimated energy use without energy efficiency improvements	1.00	1.05	1.09	1.13	1.14	1.16	1.19	1.19	1.15	1.20	1.29	1.29	1.38
Actual energy use	1.00	1.03	1.04	1.08	1.07	1.11	1.13	1.15	1.09	1.13	1.24	1.22	1.30

FIGURE 5-4: Energy Use in Commercial Buildings, 2000

	Megajoules per m^2 per year
All buildings **	1590
New buildings*, **	1330
Model National Energy Code	1460
CBIP results	950
C-2000 projects	730

* 1990-2000

** Source: Commerical and Institutional Building Energy Use Survey, 2000. Estimates relate only to the surveyed area of populations over 175 000, and in Atlantic Canada to populations over 50 000.

FIGURE 5-5: Estimated Average GHG Reductions by Institution Under CBIP, 2003 to 2004

Building type	Number	Annual GHG Savings* (tonnes/year)	Average GHG savings (tonnes/year) 2004
Education	121	33 106	321
Health	57	12 252	272
Retail	36	6 735	217
Office	74	11 159	151
Multi-unit residential building	23	2 882	152
Other	61	11 681	225
Total	**372**	**77 814**	

* for average size building

FIGURE 5-6: Energy Innovators Initiative – Incentive Projects, 1998 to 2004

	Millions of dollars
Federal incentive	30.5
Client investment	561.0
Annual energy cost savings	80.0

FIGURE 5-7: Eighth Amendment: Estimated Reduction in CO_2 Emissions, 2005 to 2020

	2005	2010	2015	2020
Commercial CO_2 Savings (Mt)	0.02	0.07	0.12	0.17

FIGURE 6-1: Industrial Energy Use by Sub-sector, 2002

	Percent of Industrial Energy Use
Forestry	0.5
Construction	1.7
Cement	2.1
Chemicals	6.5
Iron and steel	7.5
Smelting and refining	8.1
Petroleum refining	11.5
Mining	17.7
Other manufacturing	17.8
Pulp and paper	26.7

FIGURE 6-2: Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2002

Industry	Energy Cost/ Total Production Cost
Cement	39.09
Chemicals	14.08
Pulp and paper	17.75
Aluminum	11.77
Iron and steel	11.91
Petroleum refining	2.02
Transportation equipment manufacturing	0.81

FIGURE 6-3: Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

	1990	1995	1996	1997	1998	1999	2000	2001	2002
Estimated energy use without energy efficiency improvements	1.00	1.15	1.16	1.20	1.20	1.25	1.30	1.27	1.31
Actual energy use	1.00	1.07	1.10	1.10	1.08	1.12	1.15	1.10	1.17

FIGURE 6-4: CIPEC Energy Intensity Index, 1990–2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Energy Intensity Index	1.00	1.05	1.08	1.06	1.06	1.04	1.03	0.98	0.96	0.95	0.92	0.91	0.92

FIGURE 6-5: Industrial Energy Innovators, 1995–1996 to 2003–2004

	1995–1996	1996–1997	1997–1998	1998–1999	1999–2000	2000–2001	2001–2002	2002–2003	2003–2004
Number of Industrial Energy Innovators	176	203	208	212	227	280	305	382	529

FIGURE 7-1: Transportation Energy Use by Mode, 2002

	Energy Use	Percentage
Passenger light vehicle	1037.4	45
Freight truck	711.5	31
Passenger aviation	214.4	9
Freight marine	110.5	5
Off-road	91.3	4
Freight rail	71.4	3
Passenger bus	53.2	2
Freight aviation	13.7	1
Passenger rail	2.6	0
Total*	**2306**	

* Totals do not add due to rounding

FIGURE 7-2: Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Estimated energy use without energy efficiency improvements	1.00	0.97	0.99	1.03	1.10	1.13	1.15	1.20	1.24	1.28	1.30	1.30	1.32
Actual energy use	1.00	0.96	0.99	1.00	1.05	1.07	1.09	1.13	1.17	1.20	1.22	1.21	1.23

FIGURE 7-3: Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2002

	1990	1992	1994	1996	1998	2000	2002
Passenger car	72.9	71.7	66.6	62.1	58.4	61.6	63.2
Passenger light truck	27.1	28.3	33.4	37.9	41.6	38.4	36.8

FIGURE 7-4: New Car Fuel Efficiency, Normalized for Weight and Power, 1990 to 2001

Index 1990=1	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
L/100 km	1.00	1.00	1.01	0.99	1.00	0.99	0.97	0.98	0.96	0.99	0.97	0.96
L/100 km/kg	1.00	1.00	1.01	0.99	0.96	0.91	0.92	0.93	0.92	0.91	0.90	0.89
L/100 km/hp	1.00	0.98	0.95	0.93	0.91	0.85	0.82	0.82	0.79	0.79	0.76	0.75

FIGURE 7-6: Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2003

Truck Model Year	Truck Standard (11.4 L/100 km)	Trucks CAFC	Car Standard (8.6 L/100 km)	Cars CAFC
1990	11.8	11.4	8.6	8.2
1991	11.6	11.1	8.6	8.0
1992	11.6	11.3	8.6	8.1
1993	11.5	11.1	8.6	8.1
1994	11.5	11.5	8.6	8.2
1995	11.4	11.5	8.6	7.9
1996	11.4	11.3	8.6	7.9
1997	11.4	11.3	8.6	8.0
1998	11.4	11.4	8.6	7.9
1999	11.4	11.3	8.6	7.9
2000	11.4	11.1	8.6	7.7
2001	11.4	11.0	8.6	7.7
2002	11.4	11.1	8.6	7.8
2003	11.4	10.7	8.6	7.6

FIGURE 7-7: Vehicle Fuel Efficiency Awareness – EnerGuide Labels

Year	New vehicles on lot with EnerGuide label (%)	New vehicles in showroom with EnerGuide label (%)
1999	64	47
2001	77	56

Note: new data available in 2005.

FIGURE 7-8: Vehicle Fuel Efficiency Awareness – Auto$mart

Year	Recollection of information on how to reduce vehicle fuel consumption (general public) (%)	Awareness of program activities (general public) (%)
1998	30	9
2002	36	16

FIGURE 7-9: Number of New Drivers Educated Using the AutoSmart Student Driving Kit, 1997–1998 to 2003–2004

Years	Number of new drivers educated
1997–1998	92 700
1998–1999	105 975
1999–2000	120 600
2000–2001	147 150
2001–2002	171 225
2002–2003	204 975
2003–2004	185 638

FIGURE 7-11: Drivers Trained and Participation in the Fleet Vehicle Program, 1997 to 2004

	Drivers Trained	FVP Members
1997–1999	51 000	946
1999–2000	53 000	1068
2000–2001	112 846	1643
2001–2002	125 000	2707
2002–2003	149 000	2805
2003–2004	160 000	3267

FIGURE 8-1: Canadian Wind Power Capacity, 1990–2003

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Wind Power Capacity (MW)	0	0	0	19	19	20	20	21	24	124	137	214	230	327

FIGURE 9-1: GHG Emissions Reductions From Federal Operations, 1990–1991 to 2010–2011

	1990	1998	2000	2001	2002	2010 Target
GHG Emissions:	3925	3164	3044	2973	2971	2724

FIGURE 9-2: Annual Energy Savings From the FIBP, 1991–1992 to 2002–2003

	1991–1992	1992–1993	1993–1994	1994–1995	1995–1996	1996–1997	1997–1998	1998–1999	1999–2000	2000–2001	2001–2002	2002–2003
Annual additions	20	50	40	70	90	80	77	77	93	103	112	117
Annual (cumulative)	20	70	110	180	270	350	427	504	597	700	812	929

FIGURE 9-3: Federal Fleet Size and Fuel Consumption, 1995–1996 to 2002–2003

	1995–1996	1997–1998	1999–2000	2001–2002	2002–2003
Vehicles	24 854	22 796	22 462	23 313	26 233
Litres of gasoline equivalent (thousands)	88 725	75 684	78 281	63 300	68 619

FIGURE 9-4: Purchases of Alternative Fuel Vehicles for the Federal Fleet, 1997–1998 to 2003–2004

	1997–1998	1998–1999	1999–2000	2000–2001	2001–2002	2002–2003	2003–2004
Annual purchases	131	161	181	180	126	489	293

Natural Resources Canada's Office of Energy Efficiency

Leading Canadians to Energy Efficiency at Home, at Work and on the Road

Canada